A CAHNERS PUBLICATION INTERNATIONAL EDITION MARCH 31, 1987

EDN

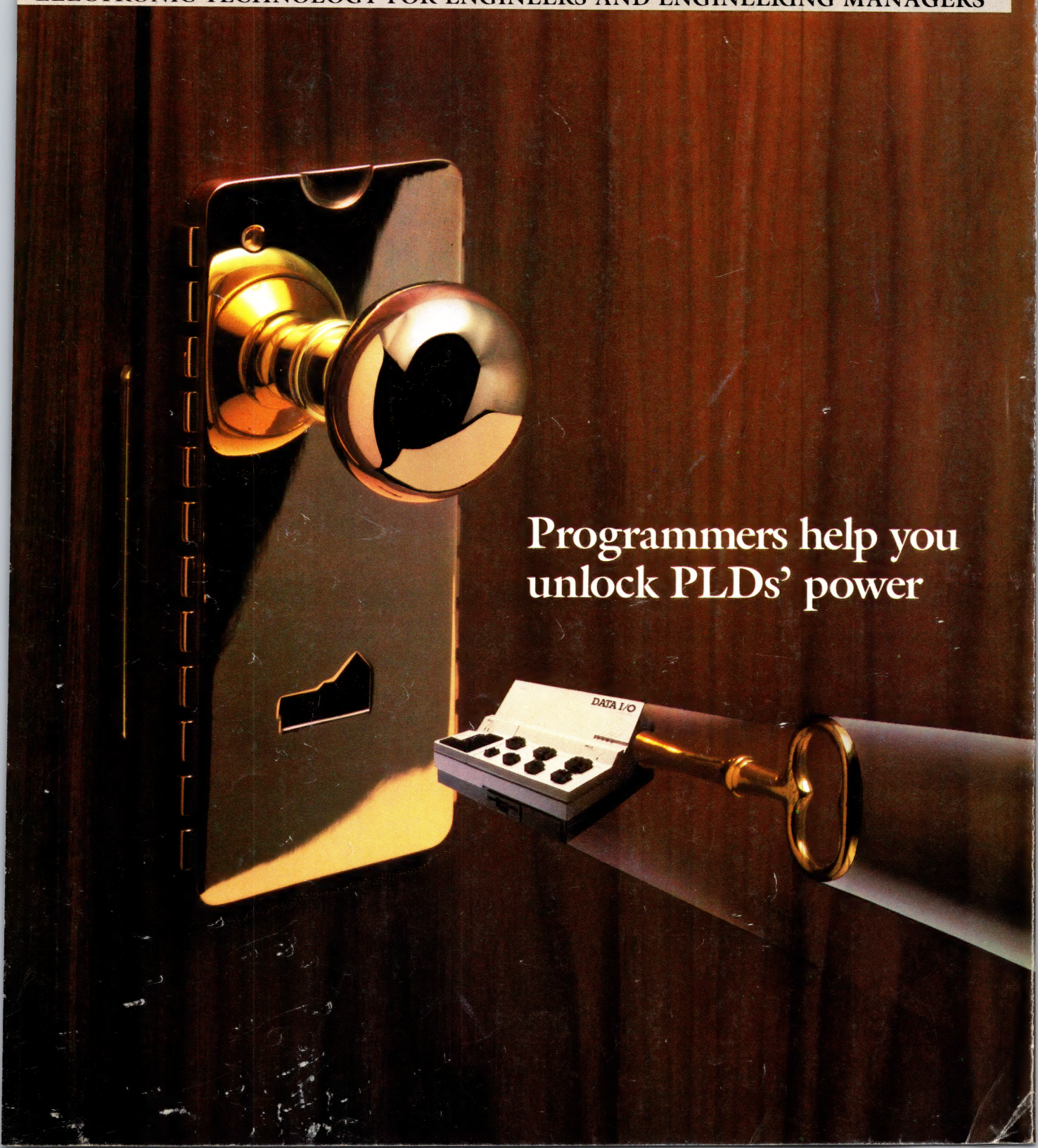
ELECTRO '87 PREVIEW: SESSIONS & PRODUCTS

Sample/hold amplifiers complement fast ADCs

Scanners and software simplify imaging systems

Microprogram monitor

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



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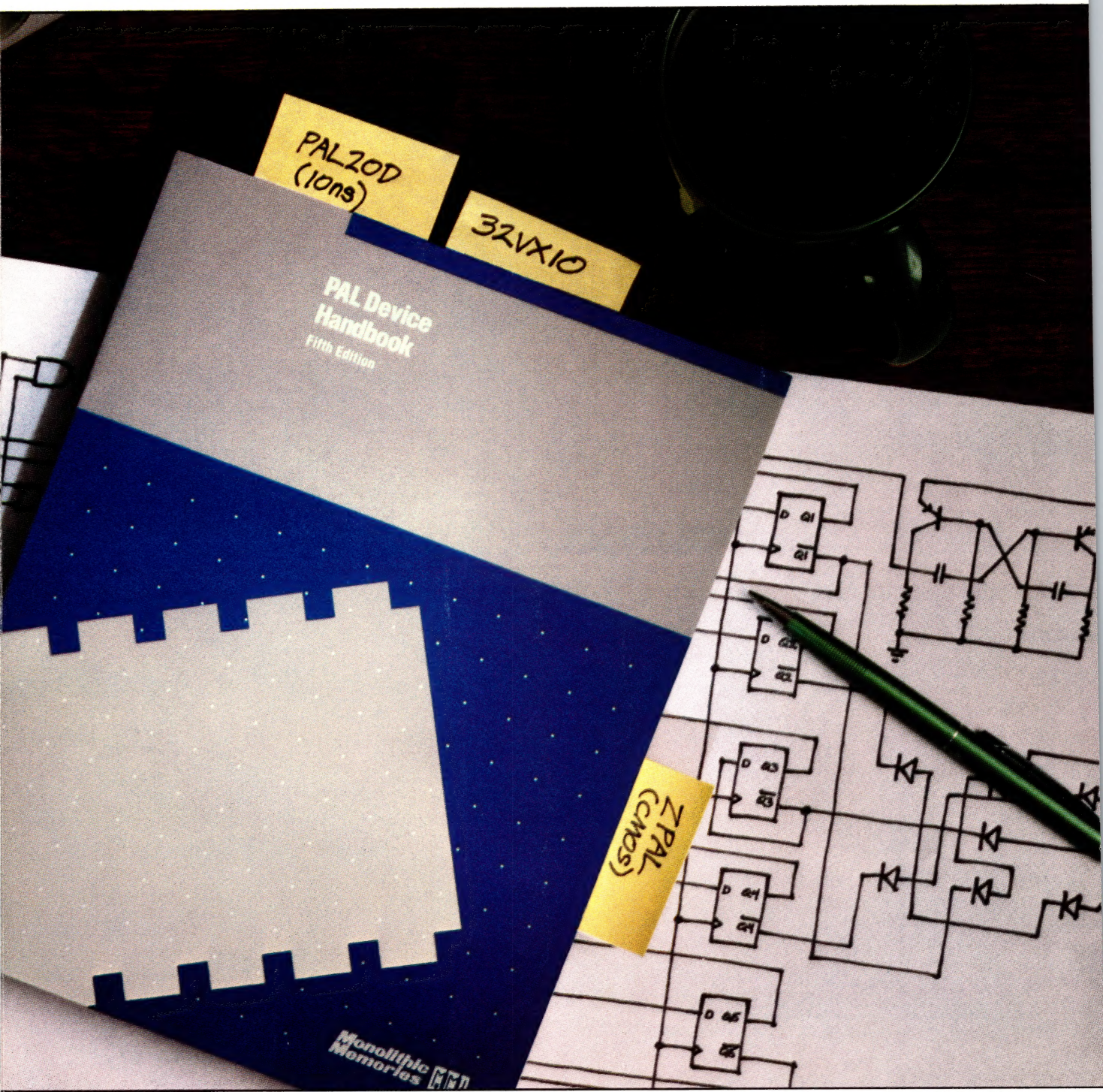

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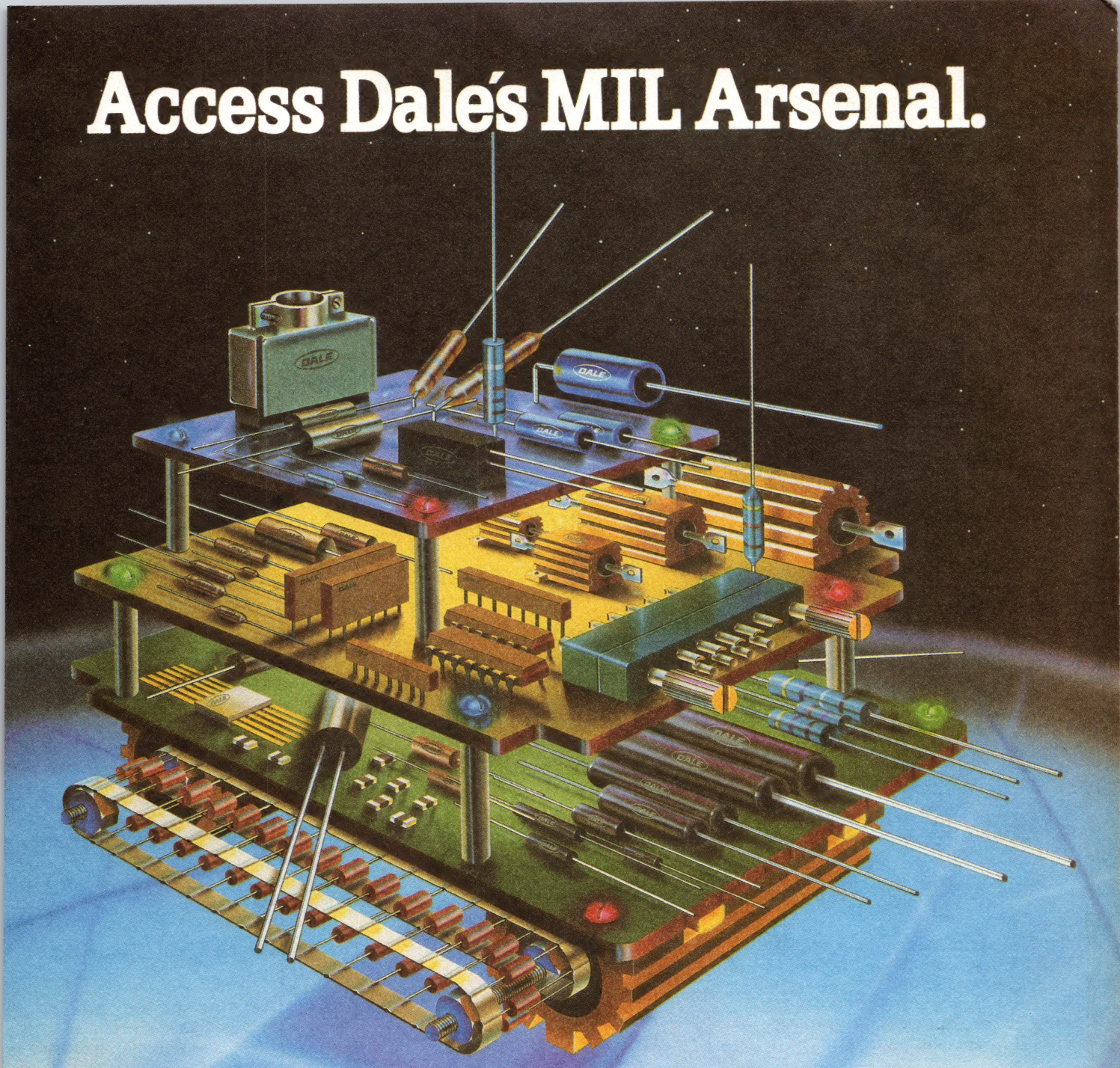

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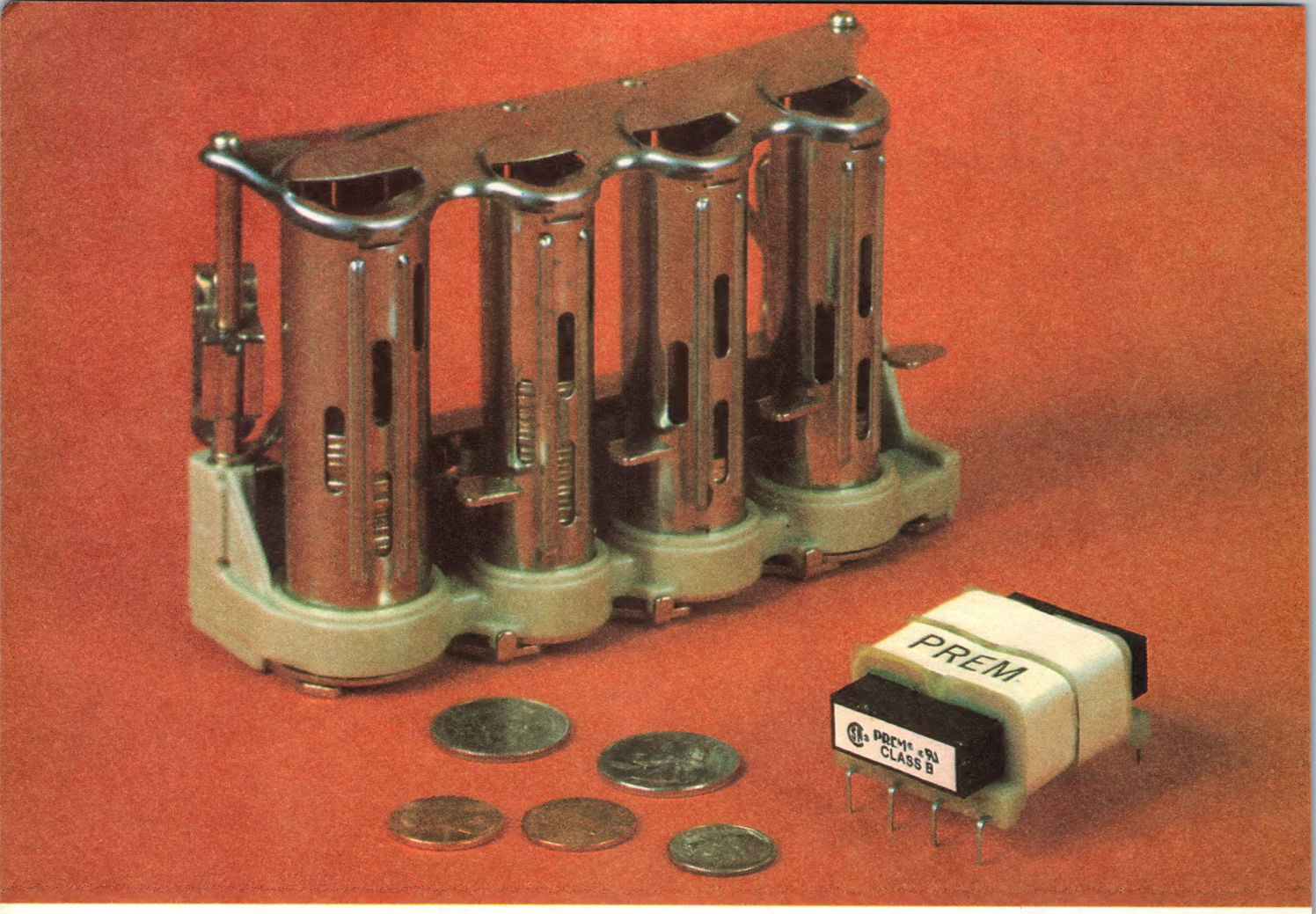

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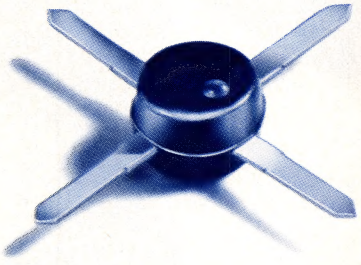


dc to 2000 MHz amplifier series

SPECIFICATIONS

Model	Frequency MHz	Gain, dB (min.)	Max. Power dBm (typ)	NF dB (typ)	Price $ Ea.	Qty.
MAR-1	DC-1000	13	0	5.0	0.99	(100)
MAR-2	DC-2000	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	8	+8	6.0	1.70	(25)
MAR-4	DC-1000	7	+11	7.0	1.90	(25)
MAR-7	DC-2000	8.5	+4	5.0	1.90	(25)
MAR-8	DC-1000	21	+10	3.5	2.20	(25)

Unbelievable, until now...tiny monolithic wide-band amplifiers for as low as 99 cents. These rugged 0.085 in.diam.plastic-packaged units are 50ohm input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer from 7 to 21dB gain, 0 to +11dBm output, noise figure as low as 3.5dB (5.5dB typical), and up to DC-2000MHz bandwidth.

**3:1 load VSWR for the MAR-8*

designers amplifier kit, DAK-1

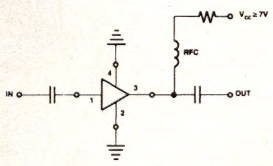
5 of each model, total 30 amplifiers only $49.99

Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each*

Size (mils)	Tolerance	Temperature Characteristic	Value
80 × 50	5%	NPO	10, 22, 47, 68, 100, 470, 680, 1000 pf
80 × 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 × 60	10%	X7R	.022, .047, .068, .1 μf

* MINIMUM ORDER 50 PER VALUE

Typical Biasing Configuration



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C113 REV. B

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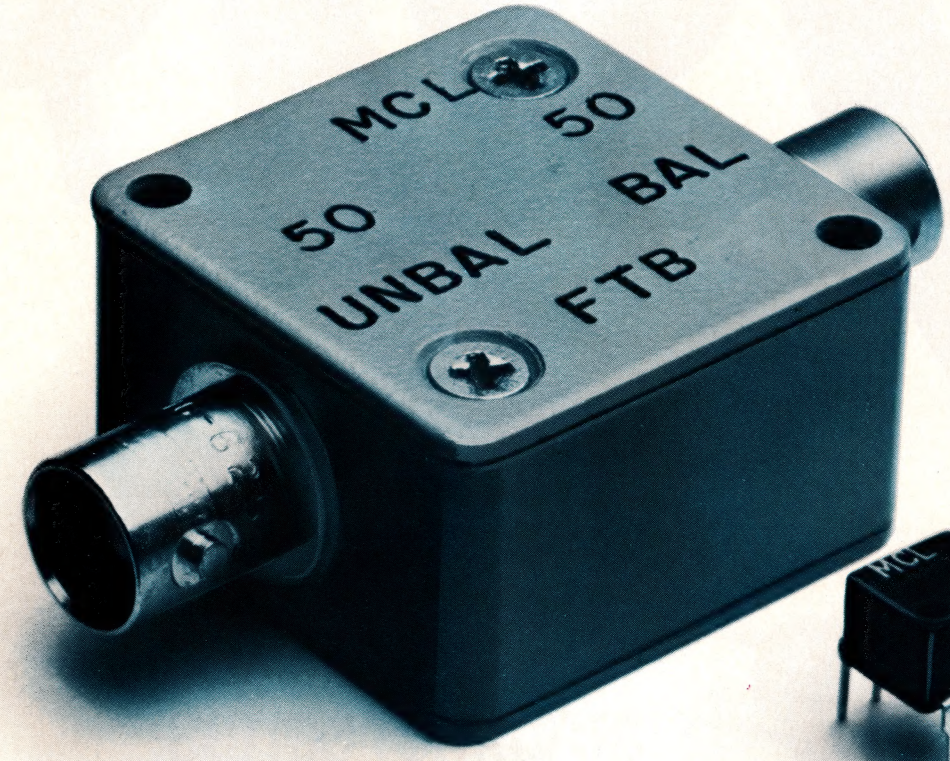
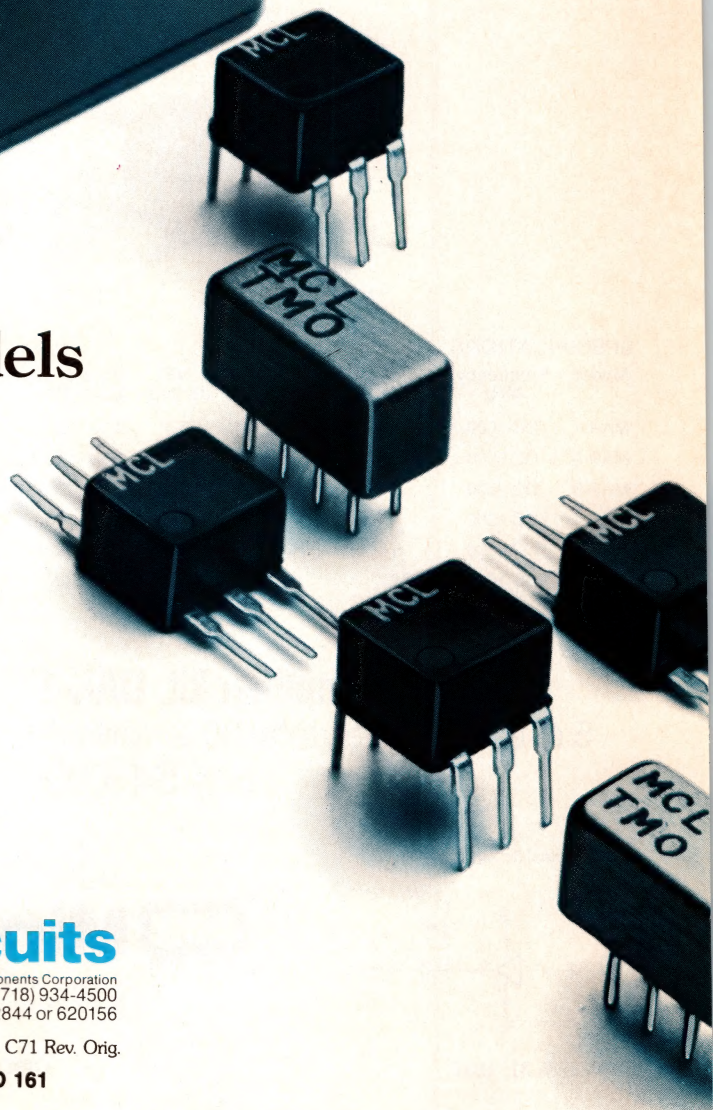
RF transformers





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CIRCLE NO 161

Volume 32, Number 7

EDN

March 31, 1987

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

On the cover: *PLD programmers are more than just mundane engineering tools. Key features include the ability to test PLDs and do development. See pg 118. (Photo courtesy Data I/O)*

DESIGN FEATURES

Continued on page 7

EDN (ISSN 0012-7515) is published 45 times a year, biweekly with one additional issue in January, February, March, August, and December, two additional issues in April, June, July, September, and November, and three additional issues in May and October by Cahners Publishing Co, a Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M Platt, President; Terrence M McDermott, Executive Vice President; Jerry D Neth, Vice President of Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President Production & Manufacturing; Frank Sibley, Group Vice President. Circulation records maintained at Cahners Publishing Co, 270 St Paul St, Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to EDN, 270 St Paul St, Denver, CO 80206.

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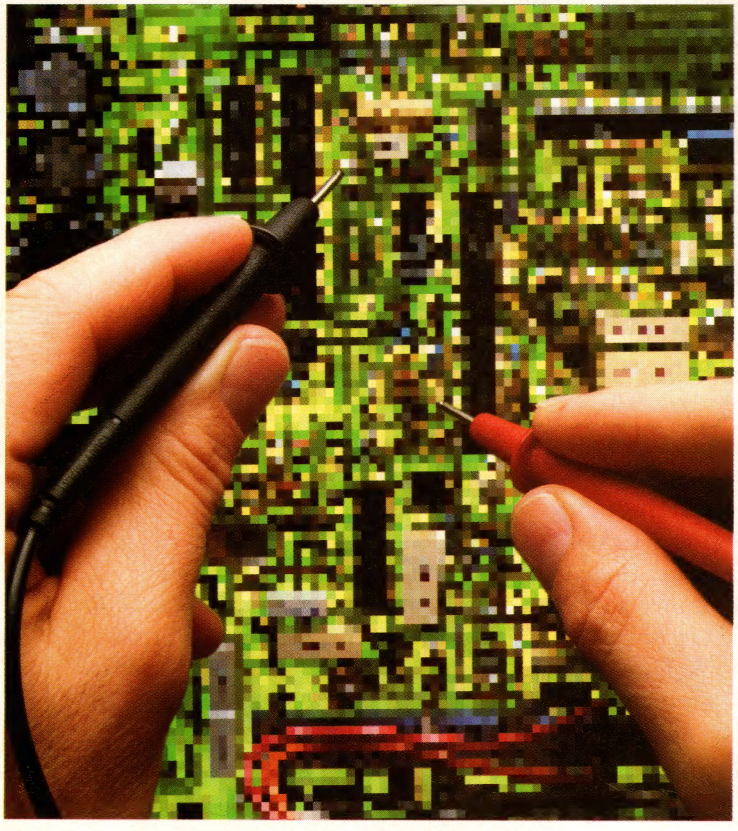

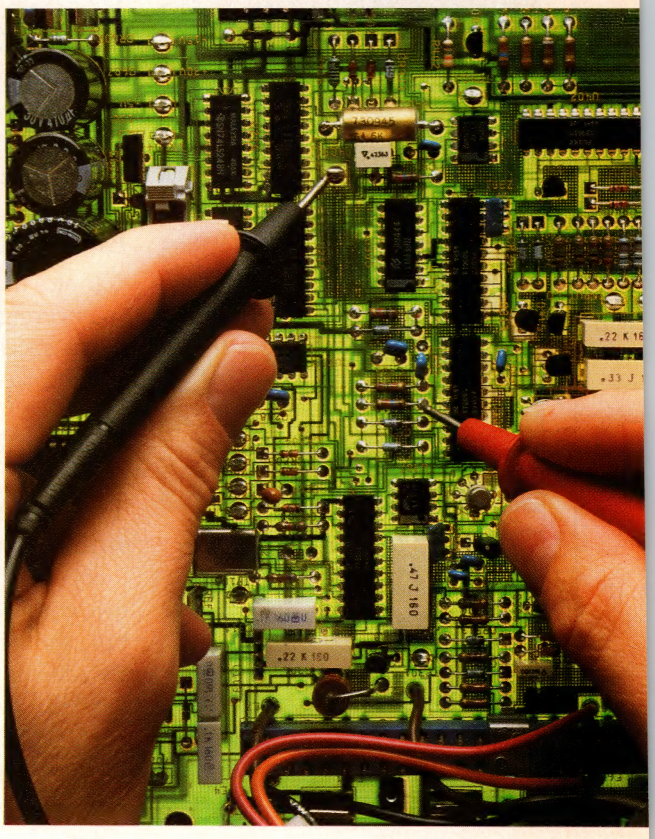

Clear up the uncertainty in your test measurements with these three versatile Fluke multimeters.

When you need performance that leaves no room for doubt, focus on the Fluke 25, 27 and 37 Analog/Digital Multimeters. With their patented A/D converters, they deliver DC volts accuracy within 0.1%. An easy-to-view display also provides a full 4 digits of resolution for readings up to 3200 counts.

Fully sealed, drop proof cases protect the handheld Fluke 25 and 27 from abuse on the job site. The unique design of the Fluke 37 is well suited for benchtop and portable use, and includes a convenient storage compartment for test leads and small accessories.

The circuitry in each model is shielded to eliminate interference — even near motors, radar, or other transmitters. And thirty-six components are dedicated to high-energy overload protection, for you and the meter.

All three instruments offer simplicity of operation. Select functions with one rotary dial. Don't worry about range selection — it's automatic. Plus, the auto-polarity digital readout and analog bar graph give you two ways to look at the signal. The 27 and 37 also add extra features like MIN/MAX Recording and Relative mode.

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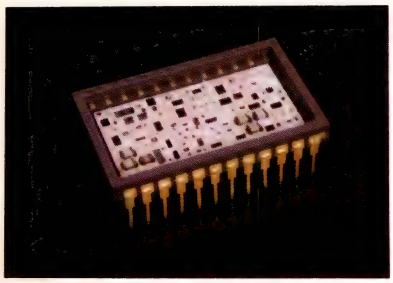

You can use sample/hold amplifiers *as peak detectors, pulse stretchers, and D/A-converter deglitchers, but their most common use is to provide quasi-dc inputs for an A/D converter (pg 59).*

TECHNOLOGY UPDATE

PRODUCT UPDATE

DESIGN IDEAS

Continued on page 9

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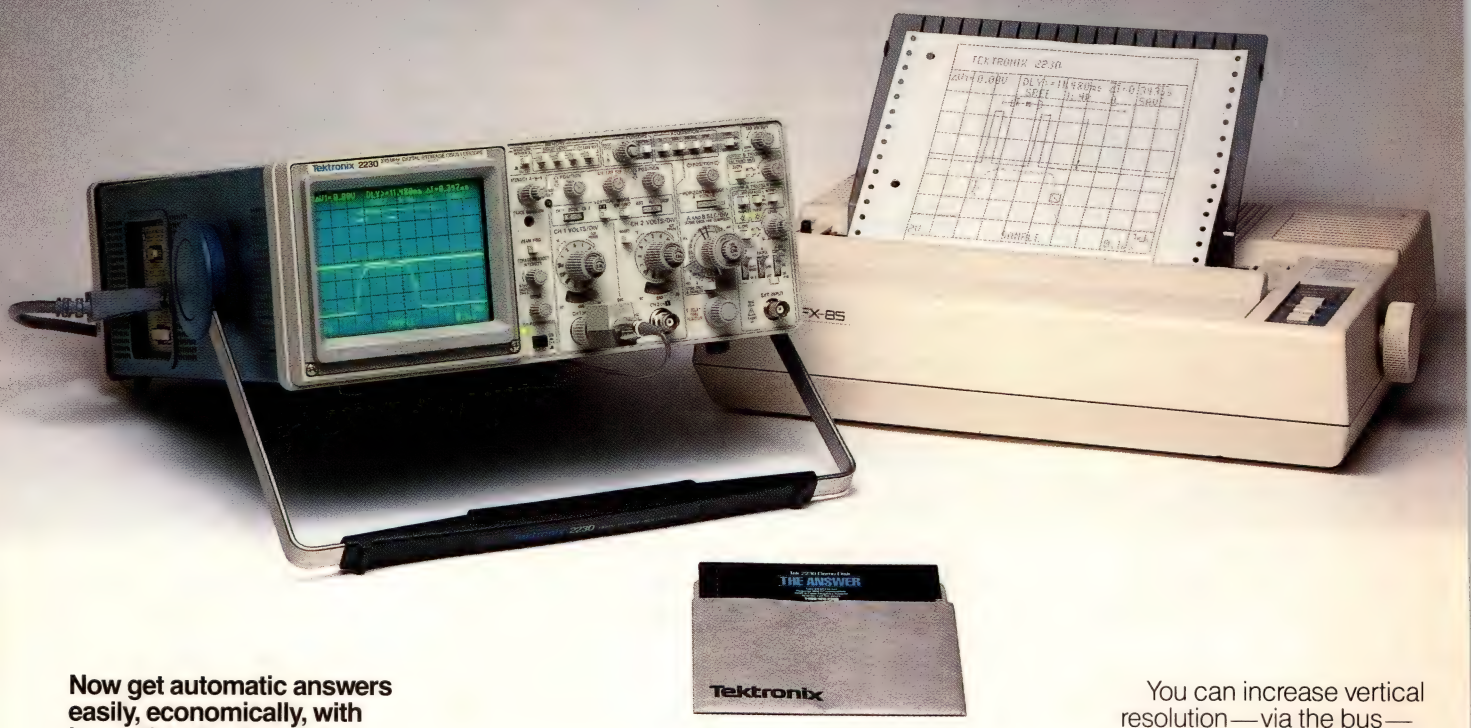

Now get automatic answers easily, economically, with immediate hard copy output. The 100 MHz Tek 2230 or 60 MHz 2220 are high-performance, high-value digital storage oscilloscopes. Equip either with an optional GPIB or RS-232-C interface and digitized data can be ported to your PC, sent over phone lines, or directed to your printer or plotter for hard copies.

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Features	2230	2220
Analog/Digital Storage BW	100 MHz	60 MHz
Max. Sampling Speed	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K
Save Reference Memory	One, 4K Three, 1K	One, 4K
Vertical Resolution	8 bits 10 bits (AVG mode) 12 bits (AVG mode over bus)	8 bits
CRT Readout	Yes	No
Cursor Measurements	Yes (storage mode)	No
GPIB/RS-232-C Options	Yes ($850)	Yes ($550)
Battery-Backed Memory (save 26 waveform sets)	Yes (inc. with 2230 communications options)	No
Price	$5150	$4150

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EDITORIAL 51

Before we can attempt to achieve great things, we must master the fear of failing. Often there is a special person in our lives who helps us overcome that fear.

NEW PRODUCTS

PROFESSIONAL ISSUES 291

After the shakeout: On-line job hunting comes of age.—*Deborah Asbrand, Associate Editor*

LOOKING AHEAD 309

Fiber optics is the choice for undersea communications . . . Military and video use will drive ADC, DAC market.

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Device	Access Times
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LOW POWER DATA RETENTION CMOS SRAMs		
Device	Access Times	Idr*
IMS1403L (x1) IMS1601L (x1) IMS1620L (x4) IMS1624L (OE, x4)	25, 35, 45ns 45, 55, 70ns 45, 55, 70ns 45, 55, 70ns	0.5μA 10μA 10μA 10μA

All above products are available in MIL-STD-883C. *Idr = Typical Icc at 2V at 25° centigrade. inmos, and IMS are trademarks of the INMOS Group of Companies.

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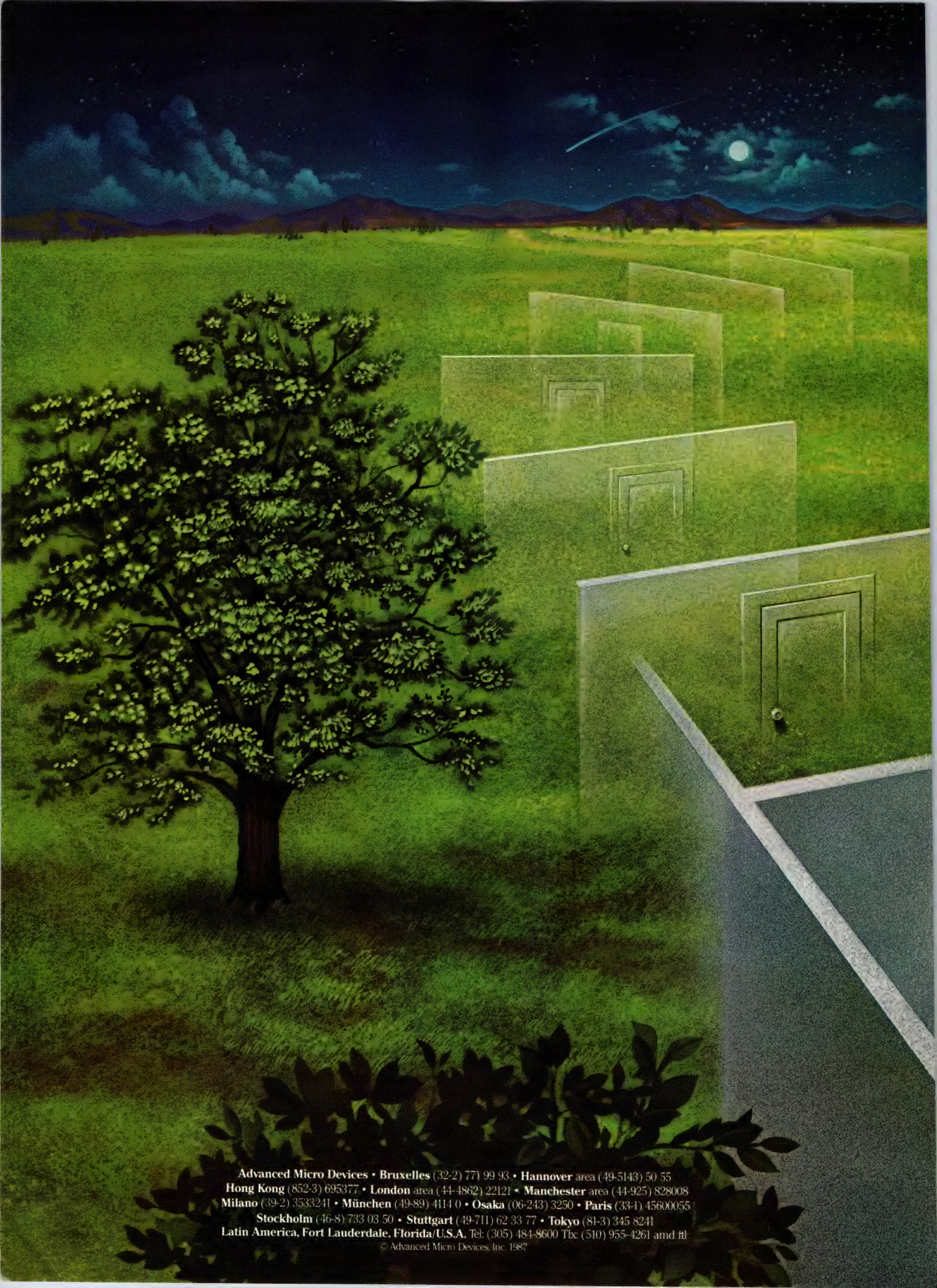

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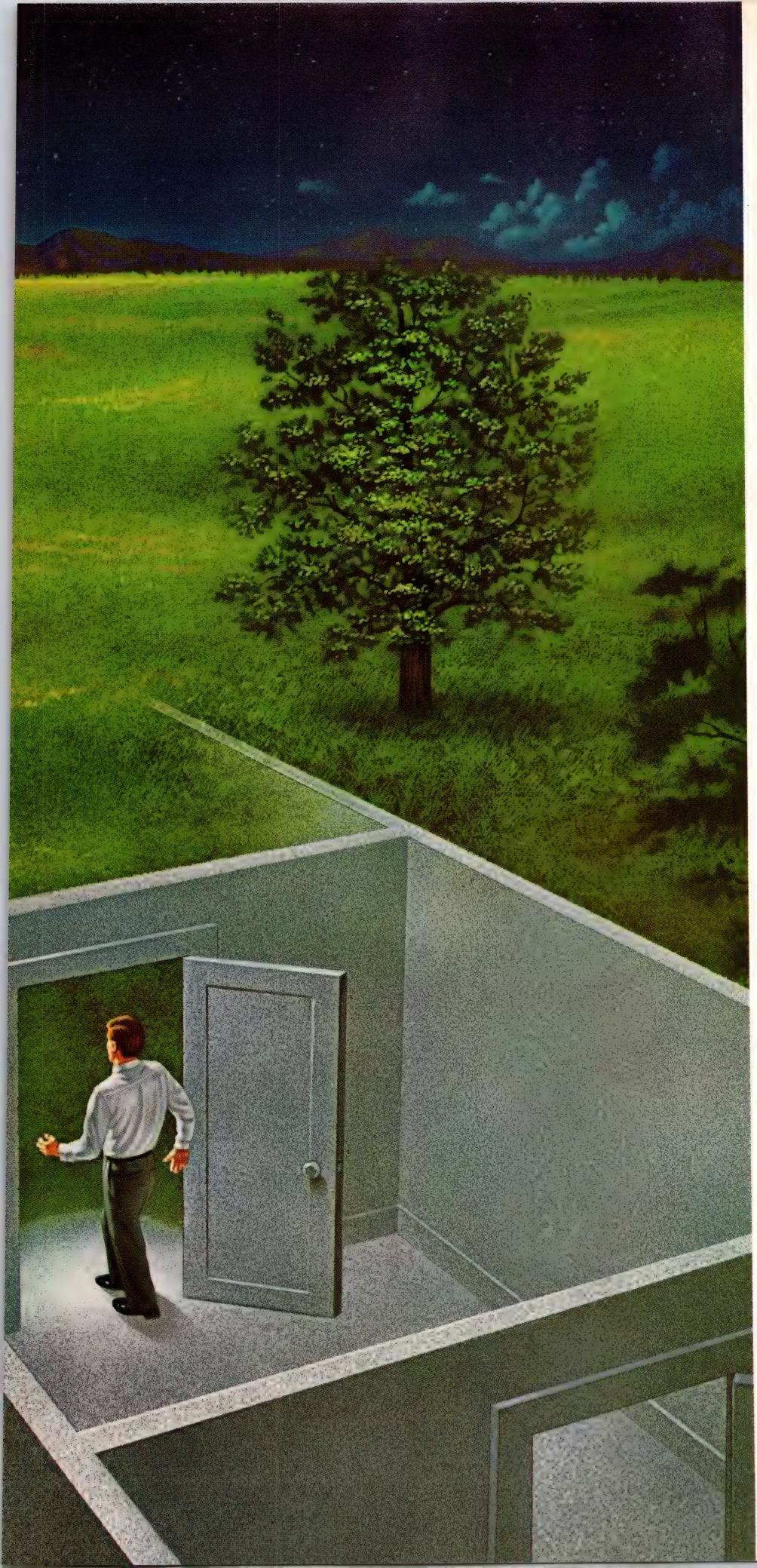

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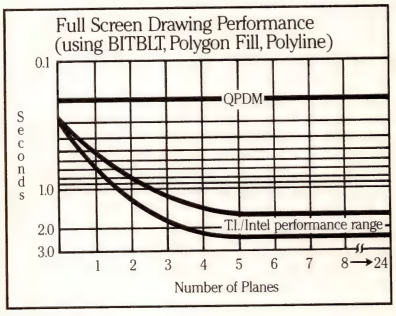
That's how we designed the Am95C60 Quad Pixel Dataflow Manager, a CMOS graphics coprocessor that proves "high performance graphics" is no longer a contradiction in terms.

With a polyline draw speed of 110,000 vectors per second, a BITBLT transfer of 55ns per pixel, and a polygon fill of 20ns per pixel, QPDM can change a screen faster than the speed of thought. (It can redraw a 1K X 1K screen in 0.2 seconds.)

Besides being powerful, this animal is highly trained. The instruction set for full graphics and text primitives is already on the chip. There aren't any extra programming hurdles to slow it down.



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CIRCLE NO 128

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CIRCLE NO 178

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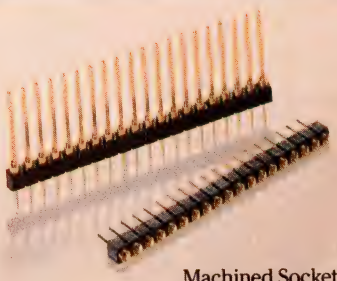

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All of which makes the IH9108 ideal for microprocessor-based instrumentation, ultrasound medical equipment and process control systems.

For complete details about the IH9108 and a free sample, call Intersil toll-free at

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Or for on-line information on your ASCII terminal or PC, dial 1-800-345-7335 (in CT 203-852-9201). You'll need a 300 or 1200-baud modem (EVEN or IGNORE parity, 7 data bits, 1 stop bit). At "Enter Response Code," type GEIHVMUX.

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RCA

CIRCLE NO 146

GEI-118

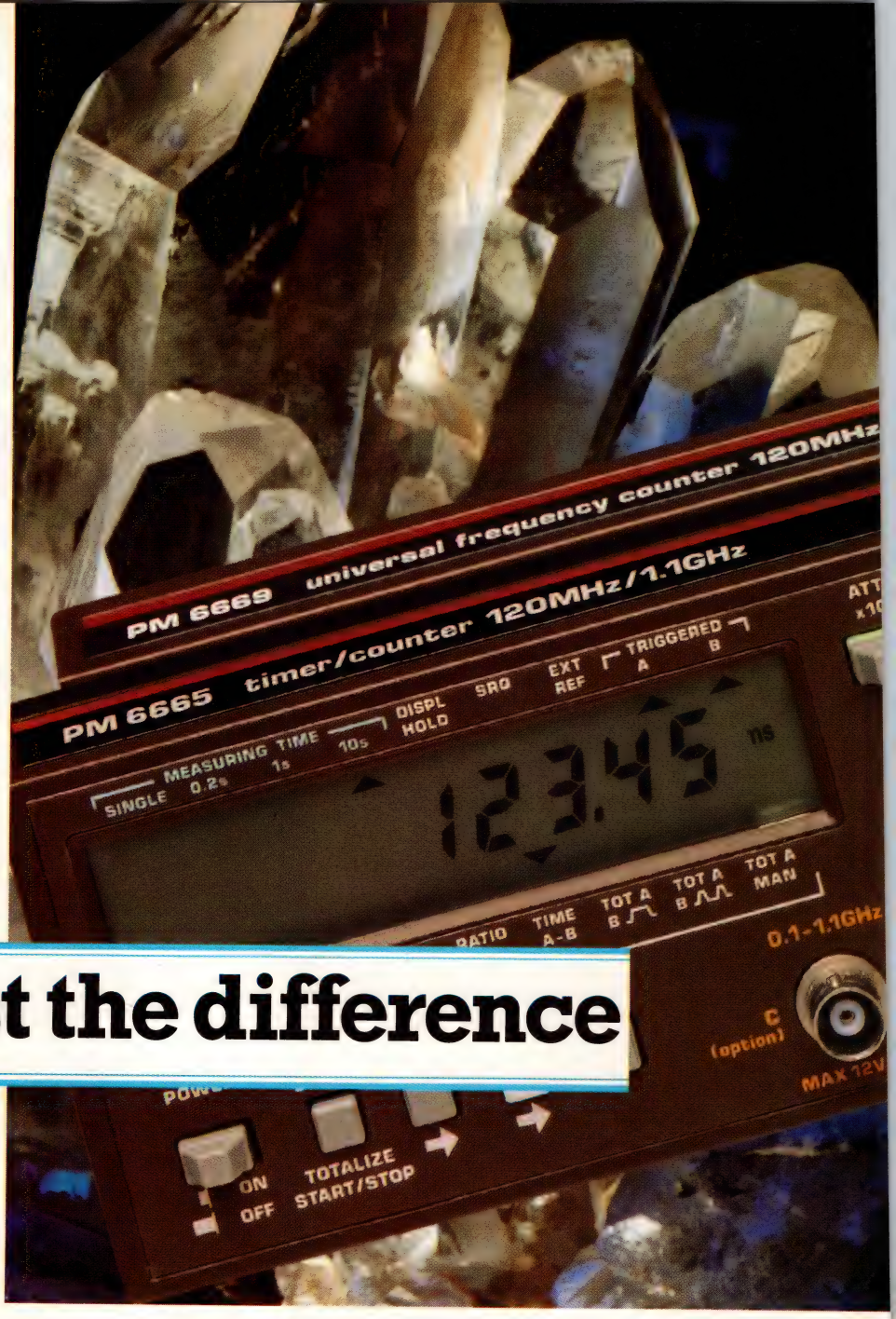
New frequency counters

Stable, able, and low in price!

Here's a pair of precision counters from Philips that leads the field in stability, capability and economy.
Both have a frequency range of 0.1Hz to 120MHz (1.1GHz optional); the PM6669 Frequency Counter featuring 8 measuring functions, including frequency difference, while the PM6665 Timer/Counter has 9 measuring functions and time interval averaging with the resolution of 20ps.

They also employ Philips' unique MTCXO concept to provide a residual temperature stability of 2×10^{-7}; a level of stability normally obtained only with oven-stabilized oscillators of high-cost instruments.

No-compromise input circuitry ensures error-free triggering under all conditions, and a selection of special-purpose options, including GPIB* interface, enhances system flexibility.



Test the difference

Product credibility in technology, technique, quality and service, too, is assured because the PM6660 series is backed by the resources of one of the world's largest electronics companies.

* GPIB = General Purpose Interface Bus; equivalent to IEC 625.1 and IEEE 488 standards.

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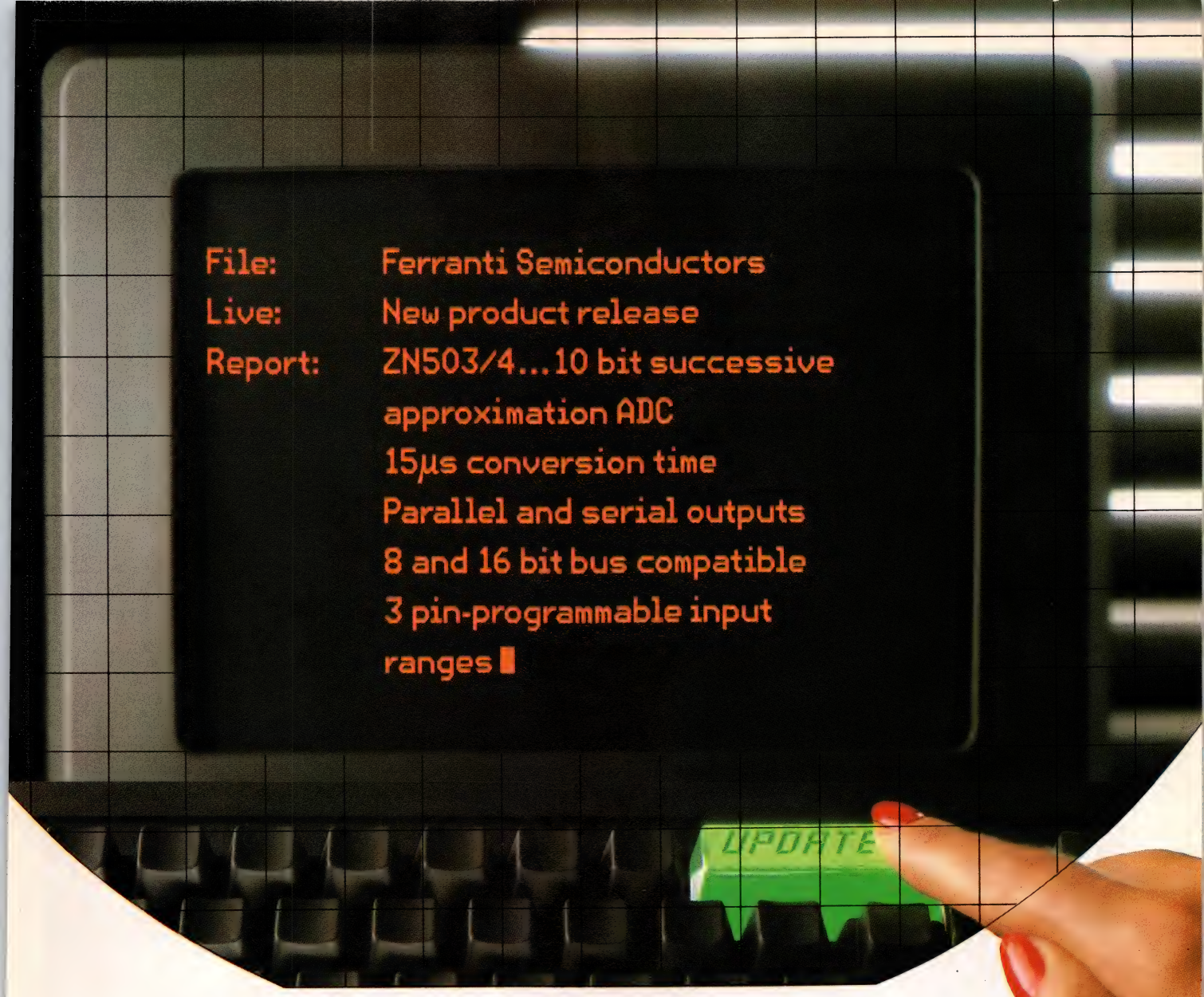
CIRCLE NO 207



Update 3... complete 10-bit ADC.

Ferranti is extending its range of standard product IC s adding new voltage references, data converters, timers, motor speed controllers, telecom and SCSI devices among others.

Our philosophy is to provide system solutions at an economic cost. To achieve this, many of the products are designed to require little or no external circuitry.

However, sometimes the need for flexibility in system design requires a less dedicated approach. Ferranti also offers many of the sub-functions in monolithic form.

Ferranti is also very aware of the increasing demand for surface mounted packages, so most products are available in SO and LCC s. But perhaps the best reason for buying from this product range is that Ferranti is committed to it.

To implement this commitment we have teams of design, application and marketing engineers whom you are welcome to consult and a wealth of data and application reports to make the design-in function that little bit easier.

Watch this space for the latest update.

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CIRCLE NO 124

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Stag's ZL30A offers total PLD programming support

Stag Microsystem's model ZL30A is the first dedicated Logic Programmer of its kind that not only supports programming of PLDs, EPLDs, and GALs*, in a variety of 20, 24, 28 and 40 pin DIP, but also supports programming of the latest surface mounted PLCC/LCC devices.

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NEWS BREAKS

EDITED BY JOAN MORROW

ELECTROLUMINESCENT DISPLAY IS READABLE IN BRIGHT SUNLIGHT

The MDS-23 electroluminescent (EL) display achieves an unfiltered pixel intensity of 225 fL at a drive voltage of 170V and a refresh rate of 300 Hz. Previous EL displays have offered an unfiltered pixel intensity of 130 fL. Its greater intensity allows you to read the MDS-23 in sunlight, suiting it for use in such applications as cockpits or brightly lit factory floors. Because the display operates at a drive voltage that's 15% lower than previous displays, you can expect greater reliability from your drive electronics. The MDS-23 measures 2×3 in.; the manufacturer, Sigmatron Nova (Thousand Oaks, CA, (805) 498-4504), can deliver custom sizes in eight weeks. The MDS-23 costs $475 with drive electronics and $375 without.—Margery S Conner

CASSETTE TAPE DRIVE STORES 5.2G BYTES ON VHS FORMAT

The VLDS (very large data store) cassette tape drive from Honeywell's Test Instruments Div (Denver, CO, (303) 773-4581) places data on standard, premium-grade VHS videotape at a 4M-byte/sec rate and stores 5.2G bytes on one T-120 cassette. The rack-mountable peripheral measures 7×17×20 in. and weighs 44 lbs. For data-acquisition applications, the tape drive can store information at the 4M-byte/sec rate for 22 minutes without pausing for a cassette change. You can purchase the drive with either a synchronous/asynchronous SCSI or a proprietary, dual, 8-bit, TTL interface. Evaluation units cost $44,000 each; the price drops to $18,900 for quantities of 150. The manufacturer will accept orders now for product deliveries in July.—Steven H Leibson

SOFTWARE DISTRIBUTES PROGRAMS AMONG INCOMPATIBLE COMPUTERS

Using Apollo Computer's (Chelmsford, MA) Network Computing System software, you can run application programs on computers from more than one vendor. The network-sharing software package requires no user intervention to distribute modules of an application program among several incompatible systems, thus letting you take advantage of any idle or partially idle computers. For example, you can use this software to run a CAE program's graphics module on a workstation and the same program's analysis module on a minicomputer.

The run-time source codes for the Network Computing System cost $250 for Apollo workstations, $1000 for Digital Equipment VAX/VMS systems, and $1000 for Unix-based computers. The compiler that transfers software from Apollo workstations to other systems costs $1000 per node or $8500 per site.—Eva Freeman

LOW-COST MICROPROGRAM DEVELOPMENT TOOL PLUGS INTO PC

You can eliminate the hassle of programming and discarding mass quantities of PROMs during microcode development with the $3995 AG-11B microprogram development tool from Agility (Sunnyvale, CA, (408) 744-0806). It consists of a target-interface board, cables, software, and a microprogram-memory emulation card containing 4k words of 96-bit-wide RAM that plugs into an IBM PC. This product loads microcode from object files in Amdasm, Step-hexadecimal, and Microtec-hexadecimal file formats and emulates high-speed microcode PROMs or ROMs. The emulation memory uses 35-nsec RAMs to achieve a system access time of 50 nsec (rated at the target side of the target-interface board). You can gang as many as four memory cards to build emulation memories as large as 192 bits×8k words.—Steven H Leibson

NEWS BREAKS

16×16-BIT MULTIPLIER/ACCUMULATOR SPECS 65-nSEC SPEED

Operating at clock frequencies to 150 MHz, the TACT1010-65 consumes 35 mA at 10 MHz and provides a 65-nsec multiply/accumulate time. This 16×16-bit parallel device from Texas Instruments (Dallas, TX, (800) 232-3200, ext 700) is fabricated in the company's 1-μm Epic (enhanced performance implanted CMOS) technology, consumes 0.5 mA in standby mode, and operates from one 5V supply. The TACT1010-65 has TTL-voltage-compatible inputs. You can drive as many as 10 low-power Schottky TTL loads from this chip's outputs. Pin-compatible with the TDC1010J, the TACT1010-65 comes in a 64-pin ceramic DIP and costs $49.10 (1000).—J D Mosley

28-PIN CHIP PROVIDES ANALOG INTERFACE FOR PCM LINES

Suitable for use with T1 and 2.048-MHz communication systems, the CS61534 PCM line interface from Crystal Semiconductor (Austin, TX, (512) 445-7222) combines the analog functions for transmit- and receive-line interfacing in a single chip. You can use the CS61534 to interface multiplexers or switching systems to a DSX-1 cross-connect; a programmable pulse-shaping line driver generates the appropriate pulse shapes for line lengths ranging from 0 to 655 ft in T1 applications. This device has a maximum range greater than 1500 ft, operates from one 5V source, and is transparent to the PCM framing format. Features include data and timing recovery, diagnostic testing, performance monitoring, and jitter attenuation. The CS61534 sells for $33 (100).—J D Mosley

FORD ANNOUNCES FULL-SERVICE GaAs FOUNDRY

Ford Microelectronics Inc (Colorado Springs, CO) has announced a full-service commercial foundry capability for gallium arsenide integrated circuits. The foundry is currently producing a 1000 equivalent gate array. The company's E/D (enhancement/depletion) GaAs process achieves 150-psec gate delays (loaded) and supports analog and digital functions.

The GaAs circuits are manufactured in Ford's clean room, which features automated cassette-to-cassette wafer handling of 3-in. wafers. Capacity is 500 wafers/week. Automated testers verify the various functions of completed circuits. The foundry is complemented by an array of design and layout services. Physical designs are completed using both Calma and Daisy systems. Detailed circuit design and analysis is supported by Gassim, Ford's proprietary circuit simulator. For further information, phone (800) 824-0812 or (303) 528-7600.—Dave Pryce

BOARD AND SOFTWARE PUT PHIGS ON VME BUS SYSTEM

Through a joint development effort, Template Graphics Software (San Diego, CA) and Tech-Source Inc (Minneapolis, MN) put high-level graphics support onto Motorola's (Phoenix, AZ) $20,000, 68020-based Delta microcomputer. Template Graphics Software adapted Figaro, its version of the proposed PHIGS (programmer's hierarchical interactive graphics standard), to the Delta's Unix System V, release 3 operating system. Tech-Source added drivers to its $495 GDSLIB software package, allowing the Delta's operating system to use the company's $4995 GDS-3800 VME Bus graphics controller that incorporates a bit-slice graphics engine and can draw as many as 100,000 short, random vectors/sec. The companies assert that these products provide the first commercial PHIGS implementation for a microcomputer to OEMs and system integrators (as opposed to end users).—Steven H Leibson

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CIRCLE NO 179

NEWS BREAKS: INTERNATIONAL

SINGLE-CHIP FREQUENCY SYNTHESIZER SUITS MOBILE-RADIO USES

Featuring a typical current consumption of 1.5 mA, the TDD1742T single-chip frequency synthesizer from Philips's Elcoma Div (Eindhoven, The Netherlands, TLX 51573) is suited for use in hand-portable, multichannel VHF/UHF radio transceivers. Despite its relatively low cost (sample devices are available now for approximately $20), the synthesizer meets all the requirements of the Amps (advanced mobile phone system) and Tacs (total access communication system) 900-MHz cellular-radio standards.

The synthesizer requires 7V min and accepts input frequencies as high as 8.5 MHz; a combination of digital and high-gain analog phase comparators ensures fast frequency locking and low-noise operation. You can program the synthesizer from a microprocessor or from data contained in an external PROM.—Peter Harold

CROSS-BAR SWITCH IMPLEMENTS RECONFIGURABLE TRANSPUTER SYSTEMS

Allowing you to modify the topology of Transputer systems to suit different applications, the IMSC004 cross-bar switch IC from Inmos Ltd (Bristol, UK, TLX 444723) provides cross-bar connection among 32 Transputer link inputs and 32 Transputer link outputs. Using one IMSC004 you can set up all the possible networks of eight Transputers, and you can cascade the switches to handle larger Transputer arrays. The switch handles Transputer links operating at 10M or 20M bps, and a separate Transputer link controls the switching operations. You can also use the device in other data-link routing applications. The IMSC004 operates from one 5V supply and is packaged in an 84-pin pin-grid array. It costs approximately $80 (100).—Peter Harold

SECOND-SOURCE AGREEMENT COVERS CMOS EEPROMs

Oki Electric (Japan) and Catalyst Semiconductor (Santa Clara, CA) have signed a second-source agreement that will result in a joint introduction of a 1k-bit serial EEPROM family. The devices will be compatible with serial EEPROMs from National Semiconductor and General Instrument. The two companies will also introduce 256- and 512-bit serial EEPROMs and 16k- and 64k-bit CMOS EEPROMs.—Joan Morrow

COBOL PROGRAMMING TOOLS AVAILABLE IN JAPANESE VERSIONS

VS Cobol Workbench, a Cobol programming environment, and micro/SPF, which emulates the mainframe ISPF editor, are now available in Japanese-language versions from Micro Focus (Palo Alto, CA, (415) 856-4161). VS Cobol Workbench contains a full screen editor, a visual debugging and maintenance facility, a screen painter, and other tools for creating and packaging Cobol programs. Programs written using VS Cobol Workbench appear on the screen in Japanese, and data can be processed in both English and Japanese. VS Cobol Workbench, which costs ¥800,000 (approximately $5000), and micro/SPF, which costs ¥100,000 (approximately $600), run on the IBM 5550 multistation workstation.—Joan Morrow

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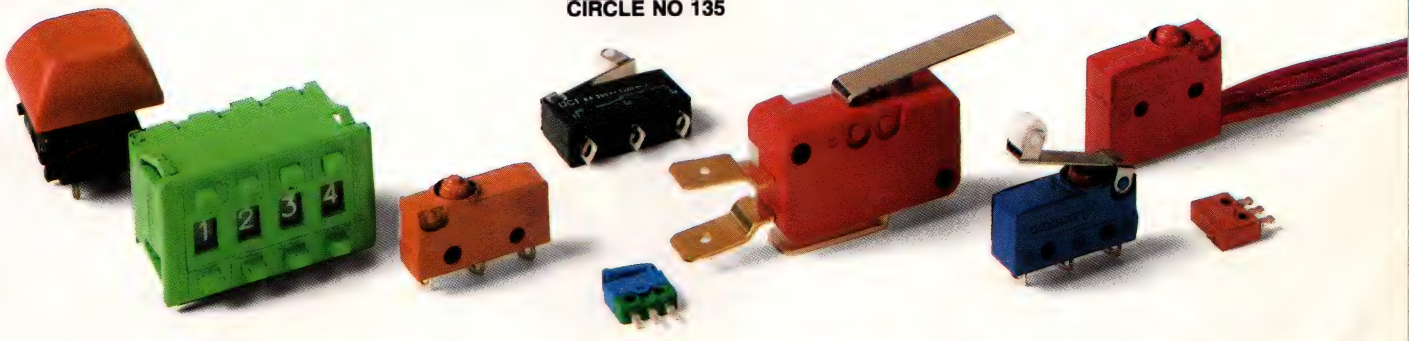

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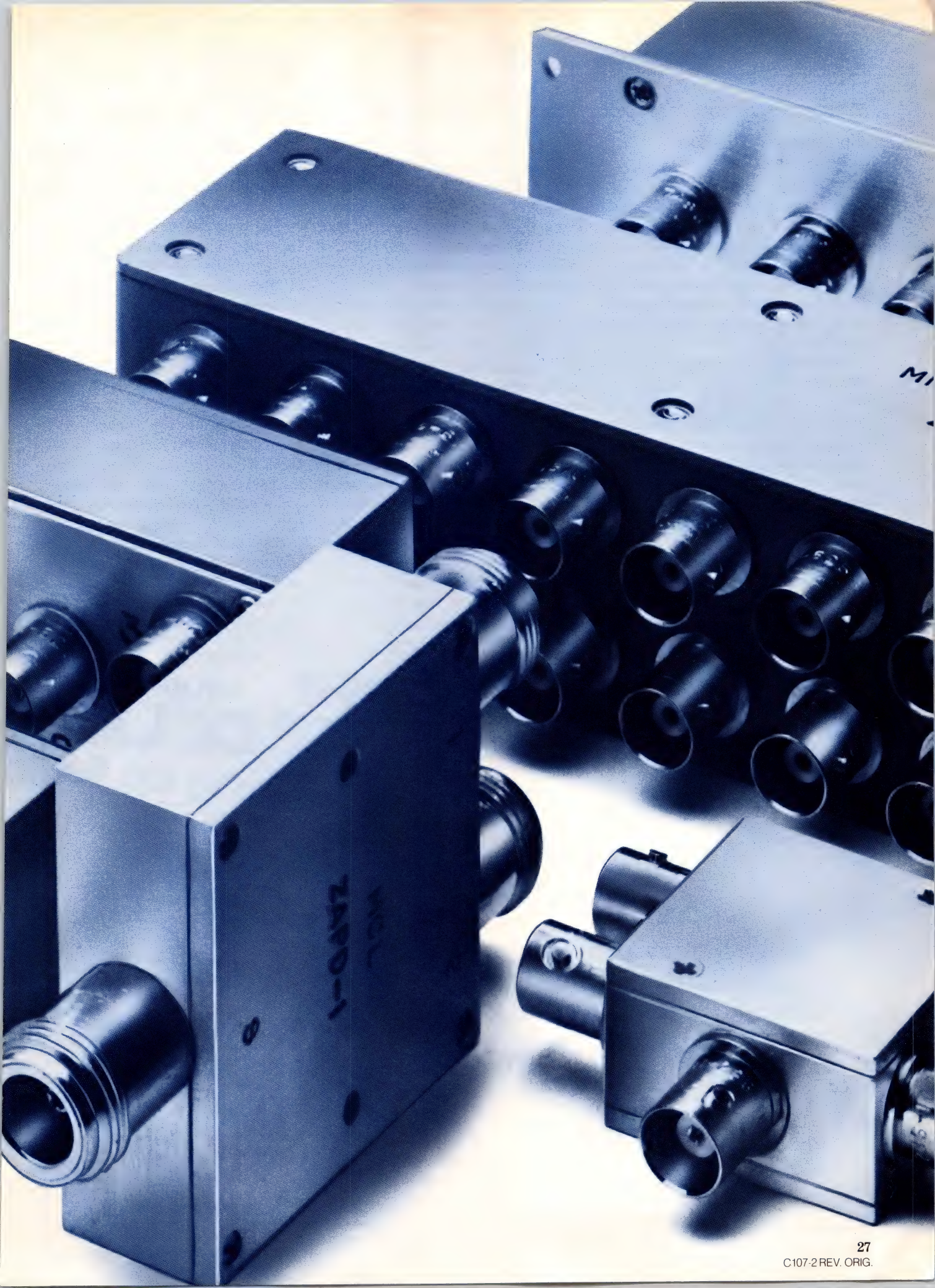

SIGNALS & NOISE

Comments on schematic editors

Dear Editor:

I was very interested in Eva Freeman's article about schematic-capture programs in the December 25, 1986, issue of EDN ("Expert designers evaluate PC-based schematic editors," pg 82). I have used one of the programs she discussed for over two years.

We chose the program after a disastrous attempt to use a schematic-capture program that was available for our local in-house timesharing system. Not only was that program bad, but the timesharing graphics terminal cost more than an IBM PC (the terminal did have better resolution, however), and the system's down time was a killer. The program we chose for the PC was actually the first one we saw that worked. It turned out to be a good program, though it took over a year to really get going.

When you use such a program, you must accept its drawing style—you can't keep your old drawing style. For example, the standard symbol blocks on the program are vertical. Many of us used a horizontal symbol in the past.

The greatest advantage of the schematic-capture program is that it eliminates human mistakes. We have eliminated the opportunity for human error in three of the design steps between the design sketch and the finished board.

The designer used to design on paper and then make wire-list coding sheets while a draftsman started a formal drawing. The wire-list coding sheets were then sent to a wire-wrap house where a keypunch operator entered the data into a computer. This procedure caused a delay in our obtaining a finished board, because the wire-wrap house usually wanted the computer printout to be proofread. Now, however, we send a floppy disk and we get back a board wired to the schematic. The board contains only the designer's mistakes, not translation mistakes. The same is true with regard to a computer-generated pc board.

The article didn't comment on the translation of the schematic net list to the format required by the pc-board program. We have had problems in this area: Many translators don't work, and the vendor of the schematic-capture program doesn't think it's his reponsibility to supply a translator that works (the translator is usually not a supported product).

One last comment: Designers shouldn't work without an uninterruptible power supply (UPS)! At the very least, you should do a save operation every 10 to 15 minutes. In

MIL-M-38510.

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CIRCLE NO 182

a summer storm, you should shut down the system on the first clap of thunder.

Further, you should use a UPS with a continuous inverter, not one that switches to the inverter when house power drops. We found that the switching type can work through a short single power drop or a long outage; however, if a few short power drops occur in quick succession, it goes off line. You need to get a continuous-inverter type that will start your computer. You must look at the starting-current requirements as well as the continuous-running power requirements.

In the same vein, you can't fool around with the PC. One keyboard mistake can erase your disk file or maybe even every file in the system. We prevent such disasters by keeping our drawings on floppy disks, one drawing to a disk.

Sincerely yours,
C R Conkling Jr
Grumman Corp
Melbourne Systems Div
Great River, NY

Modem chips for IEEE-802.4 LANs

Dear Editor:
I enjoyed Denny Cormier's article on LAN ICs (EDN, December 11, 1986, pg 136), but I was a little concerned about the article's statement that no currently available chips specifically handle IEEE-802.4 LANs.

For two years, we have been selling the NE5080 and NE5081 FSK modem transmitter and receiver, which are intended for 802.4 LANs.

Sincerely yours,
Nick Gray
Signetics
Linear Div
Sunnyvale, CA

Money problems

Because of a typesetting error, the prices that appeared in the description of Plessey's SP93808 octal comparator (December 25, 1986, pg 14) were incorrect. When reading about the device, please insert a pound sign where you see a dollar sign: The SP93808 costs £39 (1000); quad and dual comparator versions cost £26 and £15 (1000), respectively.

WRITE IN

Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

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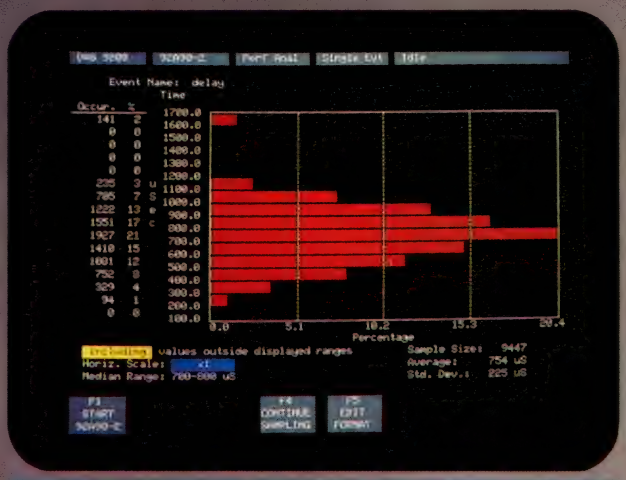
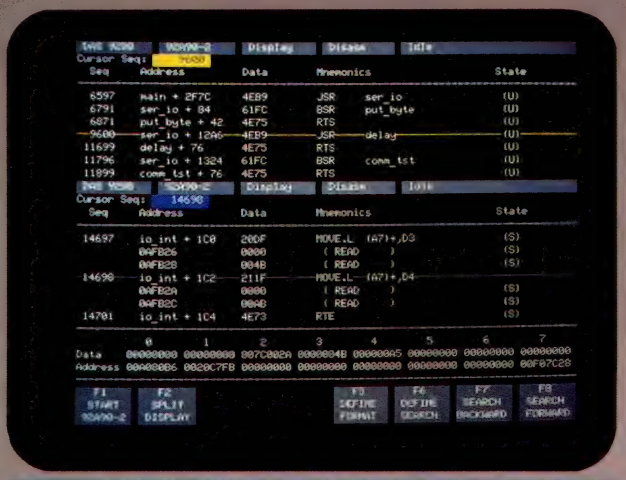


Software Performance Analysis, like this distribution of a subroutine's execution times, helps you easily understand the activity of your code.



Step backwards through acquired data, including subroutines, stack and register models, using time-correlated split-screen displays to pinpoint problems.

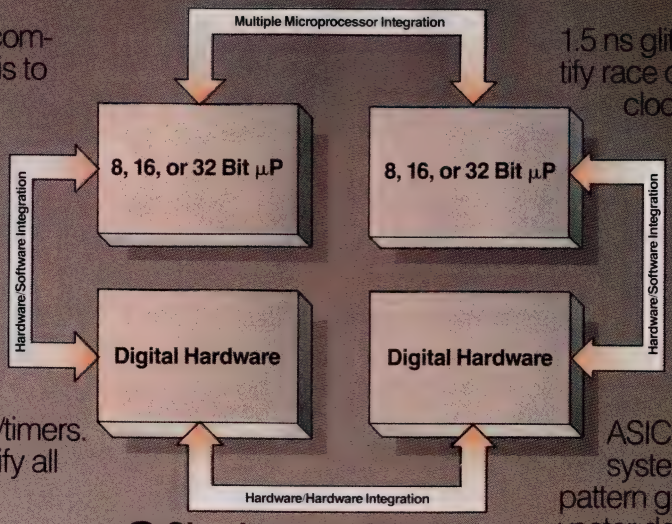
In every dimension—speed, channel width, memory depth, trigger capability, modularity and ease of use—the DAS9200 dwarfs what's been possible before.

The DAS9200 features a tightly coupled, high-speed architecture in which multiple card modules can act as a single unit. Large color-coded displays, pop-up menus, performance analysis graphs,

multi-tasking and more combine to take logic analysis to levels like these:

1 State-driven triggering at 200 MHz. You can use up to 384 channels of sync and async data acquisition. You can assurance-test high-speed logic at full speed, using 4-level state tracking and high-speed counter/timers. You can monitor and verify all timing measurements in a circuit.

2 Symbolic, real-time software debugging. Register deduction and stack simulation let you pinpoint problems like stack overflow or incorrectly restored pointers—without breakpoints or manual notation.

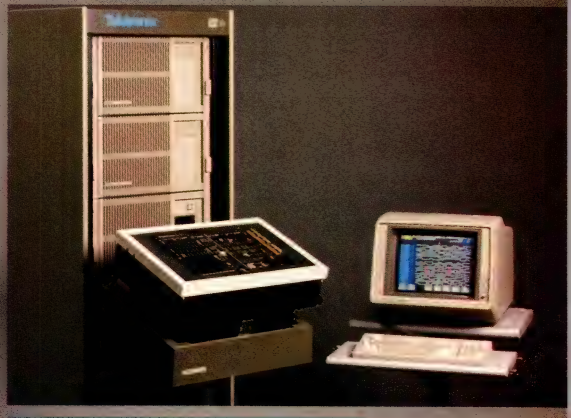


3 Simultaneous integration of up to six microprocessors. Use the dual timebases and real-time handshaking between system modules to set up split-screens displays that scroll in precise time alignment.

4 160 channels of acquisition at 2 GHz. Use up to 500 ps sample interval and 1.5 ns glitch detection to identify race conditions, spurious clocks and setup/hold violations in any logic family. System probes feature input capacitance of <1 pf.

5 Easy ASIC verification at up to 50 MHz. The DAS9200 is available as a low-cost turnkey ASIC device verification system. Featuring 50 MHz pattern generation, 8K bit vector depth, and 1 ns edge placement, it offers the power, precision and simplicity to be an attractive alternative to centralized systems.

6 Stop wishing for the impossible in digital analysis: Compare your wish list against the complete list of DAS9200 capabilities. Contact your Tek sales engineer, or call toll-free for more information. **Call 1-800-245-2036.** In Oregon, 1-213-1220.



Available in desktop and rack-mount versions, the DAS9200 mainframe can be augmented with up to three expansion mainframes for a total of 28 card slots.

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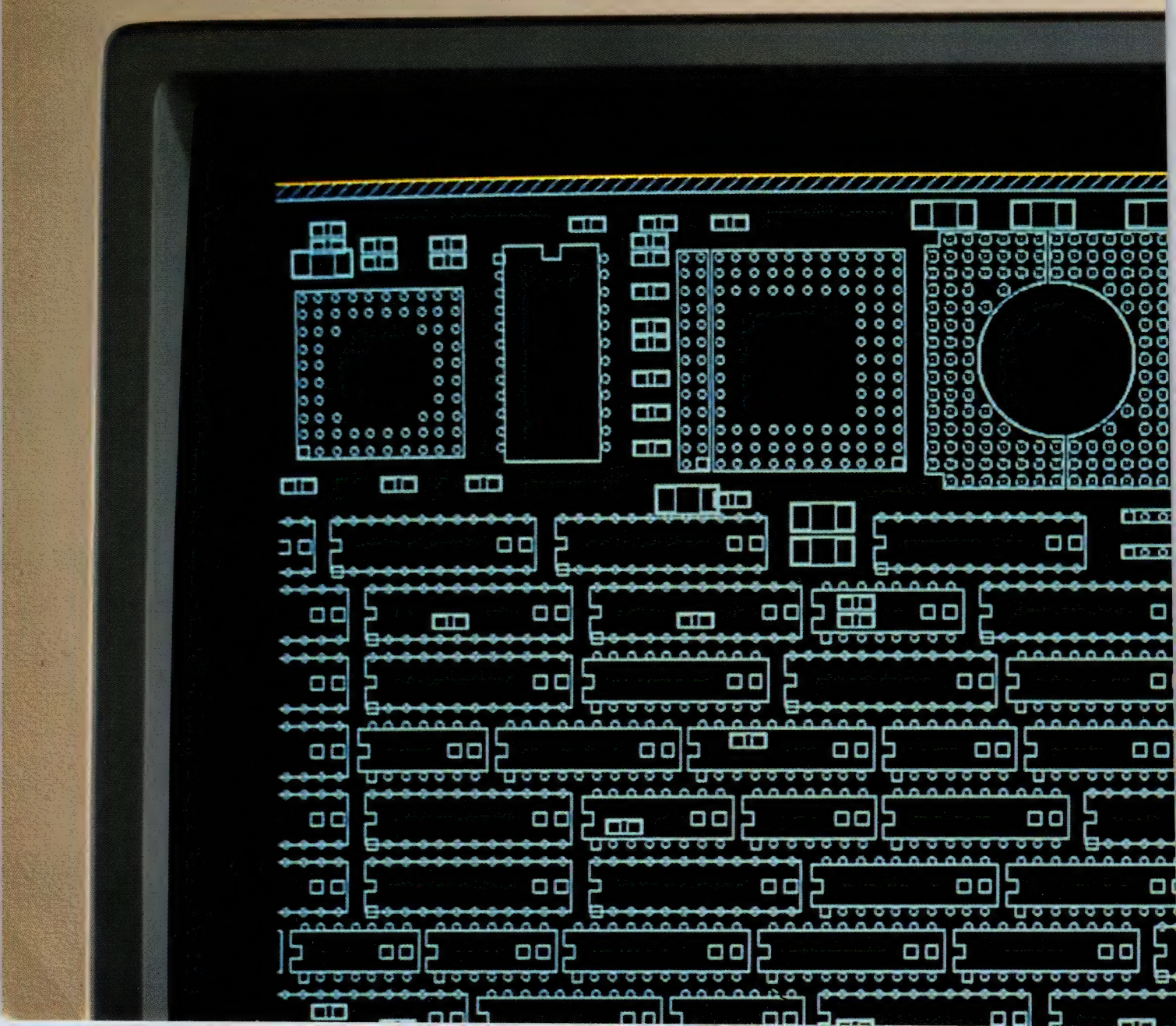

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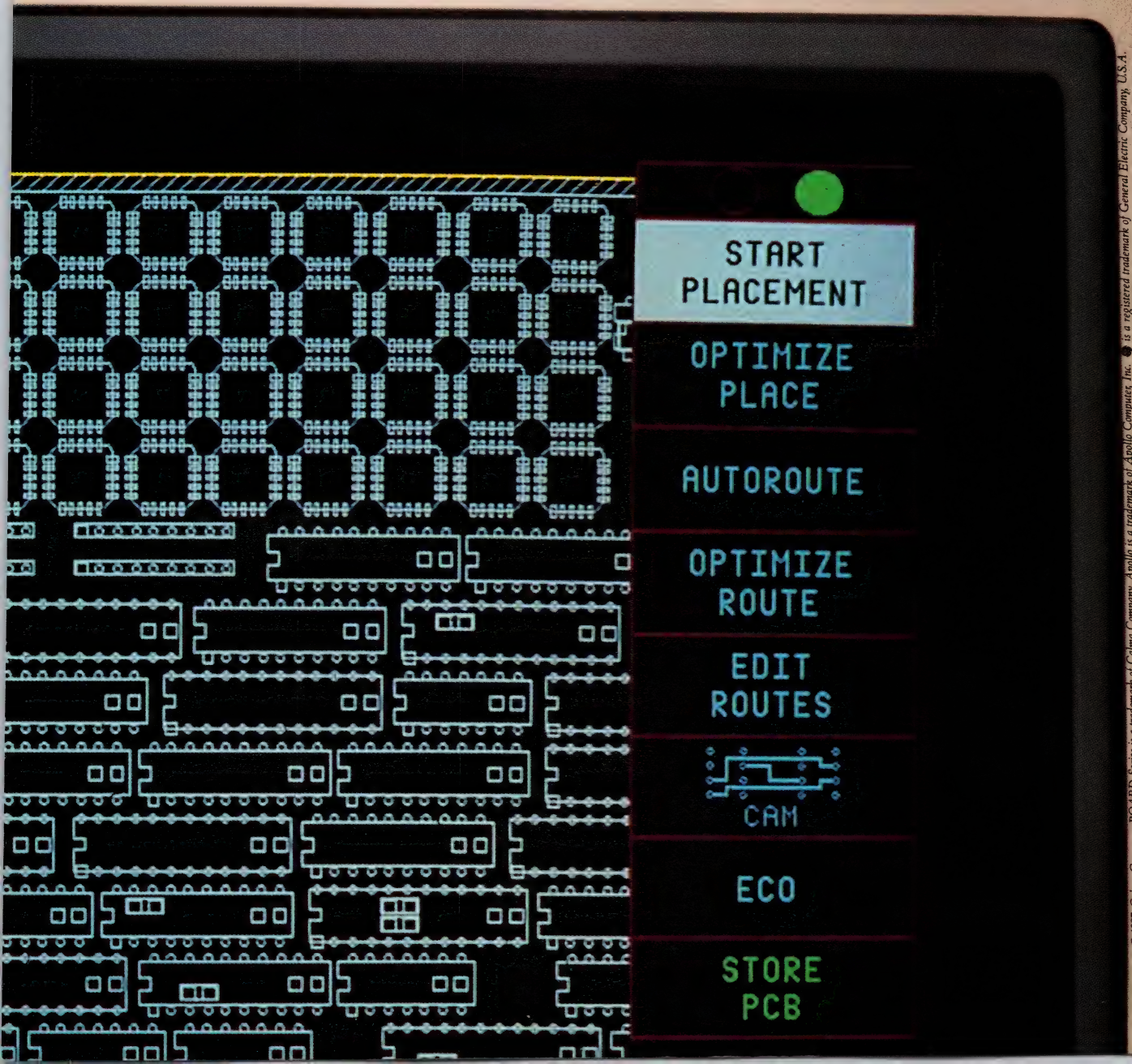

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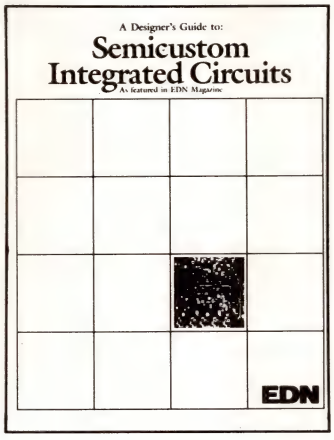

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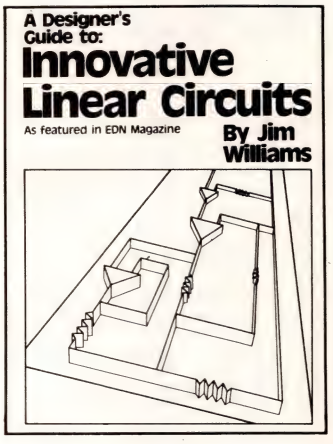

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CALENDAR

Invitational Computer Conference Computer Graphics Series, Munich, West Germany. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. April 23.

Annual Systems Conference, Louisville, KY. Association for Systems Management, 24587 Bagley Rd, Cleveland, OH 44138. (216) 243-6900. April 26 to 29.

Array Conference, Montreal, Canada. Array, Box 23489, Portland, OR 97223. (503) 641-3151. April 26 to 29.

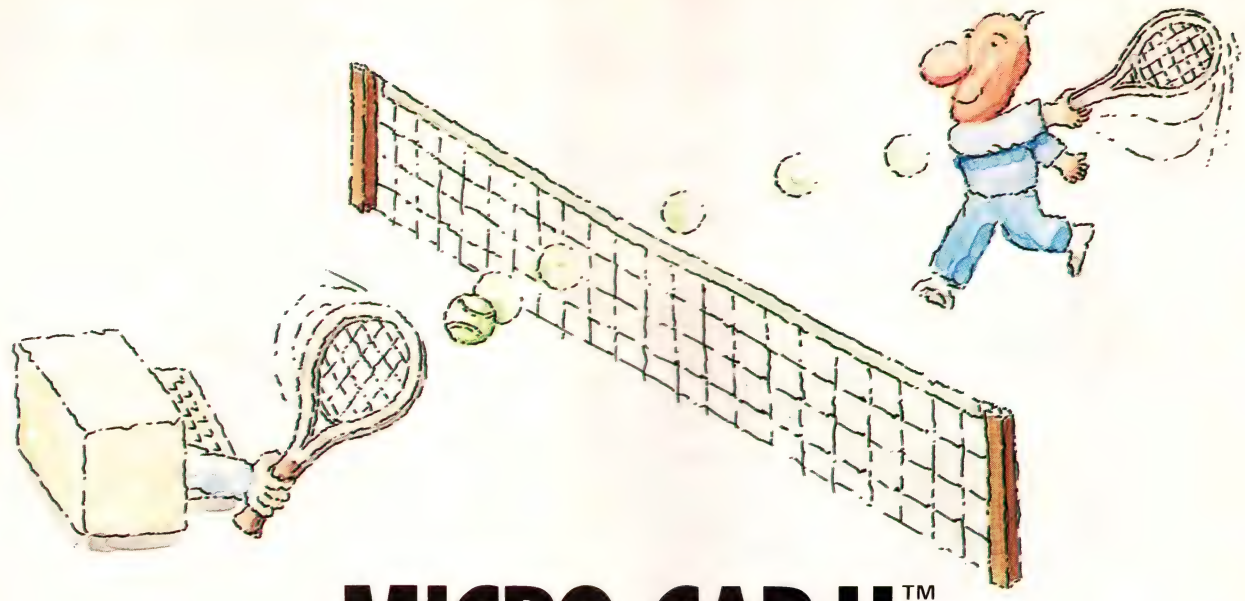
DRIP II (Defect Recognition and Image Processing in III-V Compounds) (symposium), Monterey, CA. Continuing Education in Engineering, University of California Extension, 2223 Fulton St, Berkeley, CA 94720. (415) 642-4151. April 27 to 29.

IMTC '87 (IEEE Instrumentation and Measurement Technology Conference), Boston, MA. IMTC '87, 1700 Westwood Blvd, Los Angeles, CA 90024. (213) 475-4571. April 27 to 29.

CLEO '87 (Conference on Lasers and Electro-optics), Baltimore, MD. Optical Society of America, 1816 Jefferson Pl NW, Washington, DC 20036. (202) 223-0920. April 27 to May 1.

Computer-Aided Engineering, Design, Manufacturing, and Test (symposium), Woodbury, NY. Long Island Microwave Theory and Techniques Society, c/o Bob Koelzer, Narda Microwave, Moreland Rd, Hauppauge, NY 11787. (516) 231-7000. April 28.

Dexpo South (DEC-Compatible Exposition), Nashville, TN. Expoconsul International, 3 Independence Way, Princeton, NJ 08540. (800) 628-8185; in NJ, (609) 987-9400. April 28 to 30.



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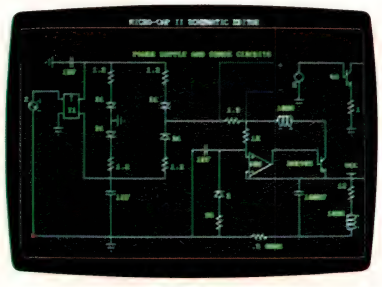

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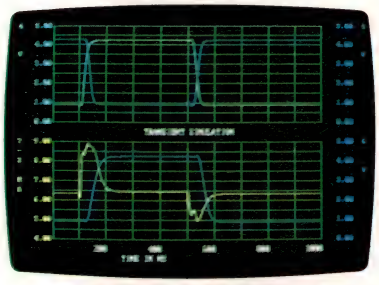

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CIRCLE NO 102

CALENDAR

British Electronics Week, London, UK. Joseph Burke, Project Manager, Rm 1015, US Department of Commerce, International Trade Administration, Washington, DC 20230. (202) 377-5014 or 377-2470. April 28 to 30.

Invitational Computer Conference Computer Graphics Series, London, UK. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. April 29.

Invitational Computer Conference Computer Graphics Series, Paris, France. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. May 5.

Custom Integrated Circuits Conference, Portland, OR. Laura Silzars, Conference Coordinator, 6900 SW Canyon Dr, Portland, OR 97225. (503) 292-6347. May 5 to 7.

Southeast Lightwave Expo, Atlanta, GA. Lightwave, 235 Bear Hill Rd, Waltham, MA 02154. (617) 890-2700. May 5 to 7.

Optical Storage Forum, Denver, CO. Cartlidge & Associates, 1101 S Winchester Blvd, Suite M259, San Jose, CA 95128. (408) 554-6644. May 6 to 8.

PC Fab Expo, San Jose, CA. PMS Industries, 1790 Hembree Rd, Alpharetta, GA 30201. (404) 475-1818. May 6 to 8.

Great Lakes Logo Conference, Cleveland, OH. Alice Fredman, Educational Computer Consortium of Ohio, 1123 S O M Center Rd, Cleveland, OH 44124. (216) 461-0800. May 7 to 8.

APL '87 (International APL Conference), Dallas, TX. APL '87 Registrar, 440 Northlake Shopping Center, Suite 210, Dallas, TX 75238. (214) 539-9281. May 10 to 14.

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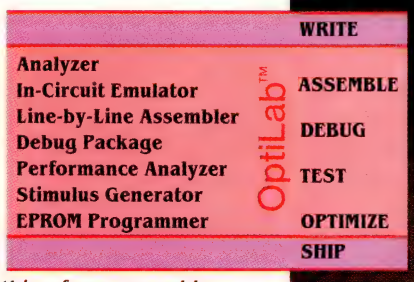

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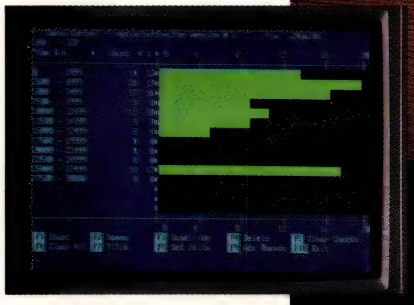

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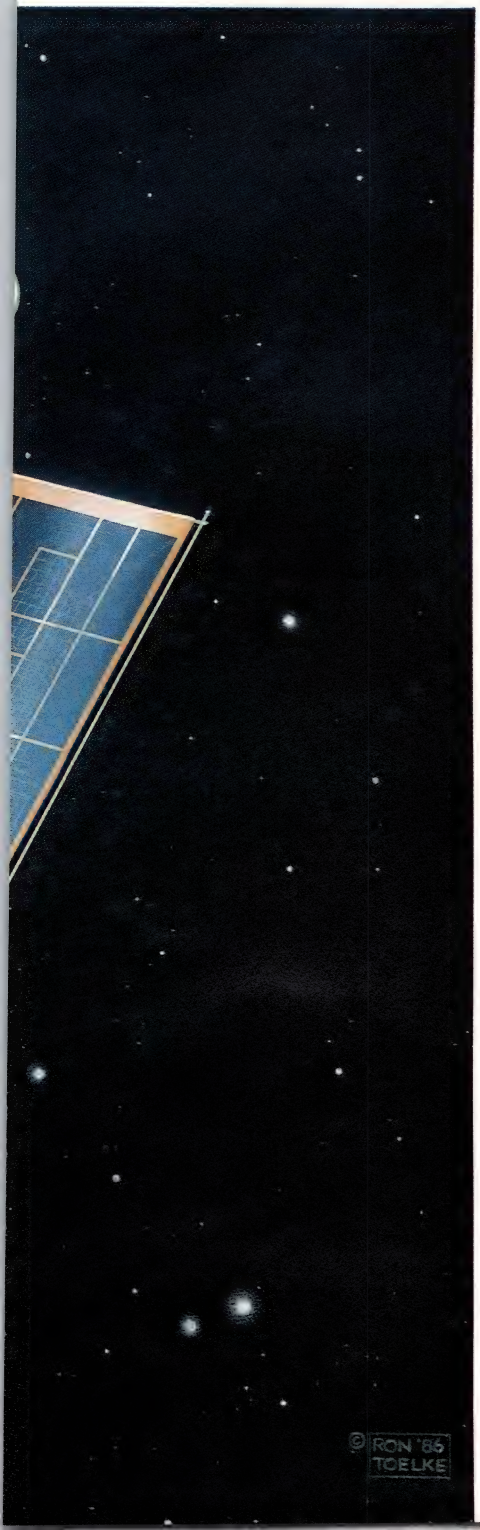

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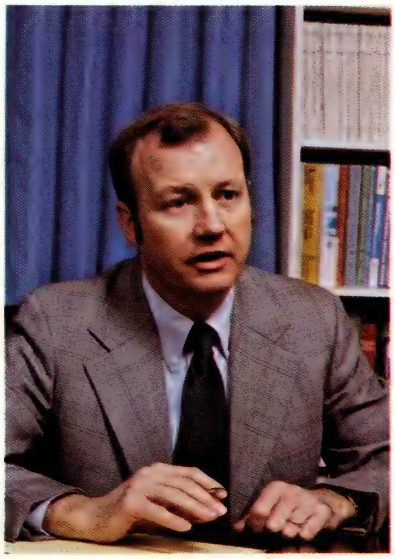
Don't fear failure

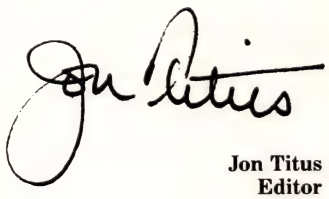


One of the keys to success and to achieving noteworthy ends is mastering the fear of failure. Unfortunately, it's a fear we learn early in life, and it's not easy to overcome. Often as children we were scolded because we did things wrong, rather than encouraged to try again. If you're still being told something like, "Look, you've tried it three times and it still doesn't work, so I'll wire it," instead of, "Not bad; debug it and let's see where you are tomorrow," you're compelled to feel that it's not worth trying something new and possibly failing at it.

Some people can learn from failure and start over again. Chances are they were never taught to fear failure, or they were taught to overcome it. What is it that helps some people overcome their fear of failure and tackle things that would discourage the rest of us? Perhaps it's the influence of someone special in our lives: a relative, a coworker, a boss, or a teacher.

One such person is John Shuttleworth, a science and chemistry teacher I know. Many kids were lucky to have him as a teacher, because he made science fun and interesting. He encouraged his students to try approaches that were new to them, even when he knew beforehand that such experiments wouldn't work. He thought it was better to let the students try something different, discover why it didn't work, and then build on that experience. With a little guidance and encouragement, most of his students mastered the problems at hand and knew how they arrived at the solutions. I don't think John ever said, "No, that won't work; you've got to do it this way. . . ." Instead it was, "What do you think will happen if you do it that way?" Or, "Try it that way and see what happens." At least in science class, John's students weren't afraid to try something new and risk failing at it.

The possibility of failure didn't deter pilots Richard Rutan and Jeana Yeager from making an around-the-world flight in the experimental aircraft Voyager. I wonder if somewhere along the way to their joint success Yeager and Rutan knew someone like John Shuttleworth.



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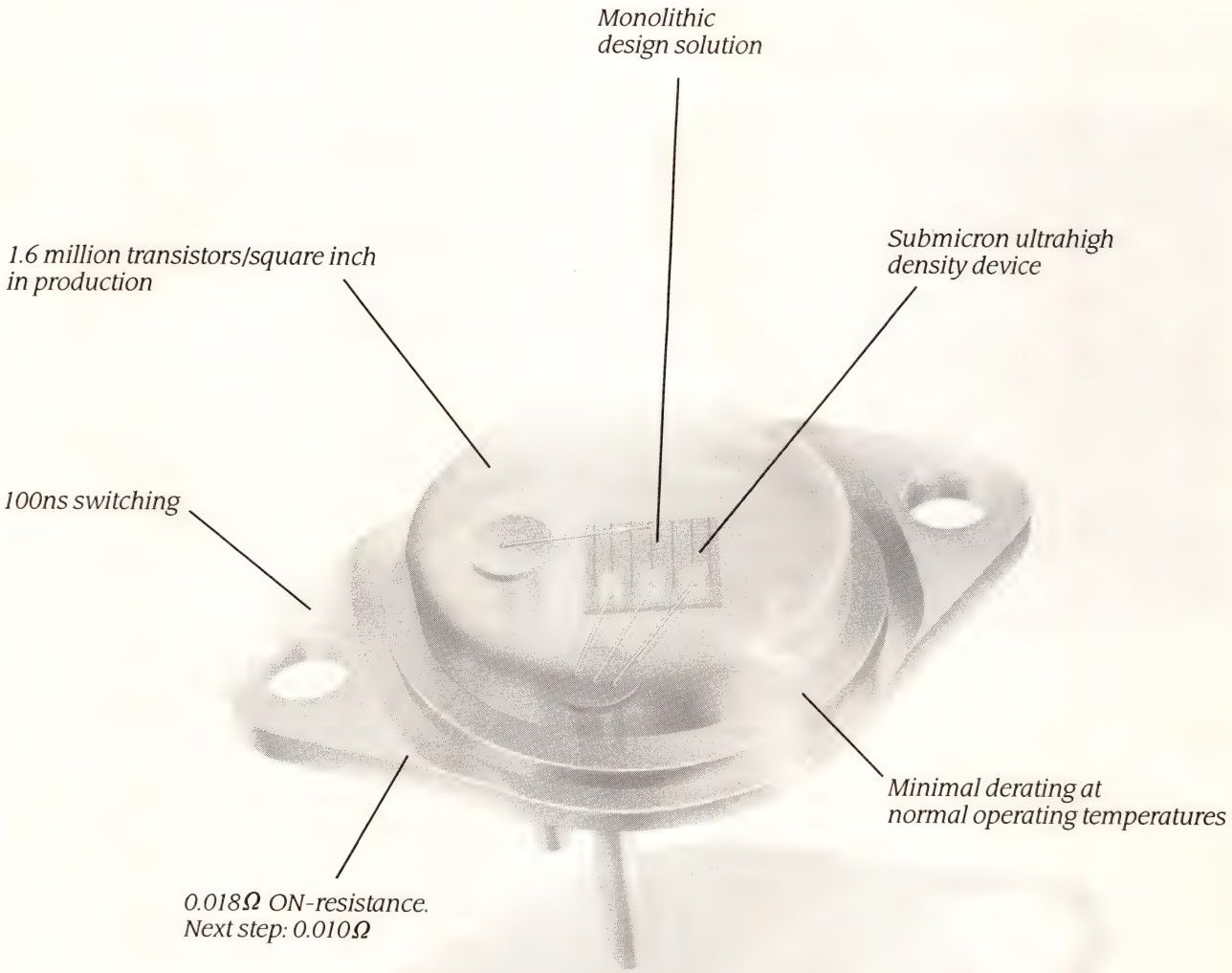

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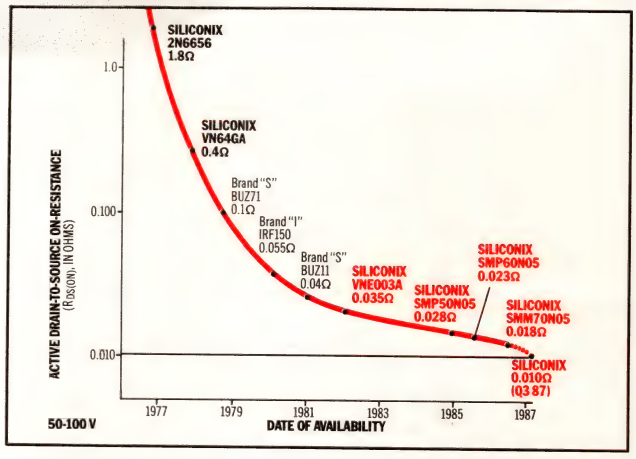

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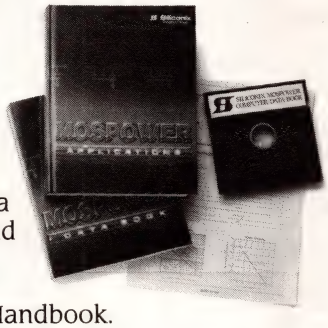

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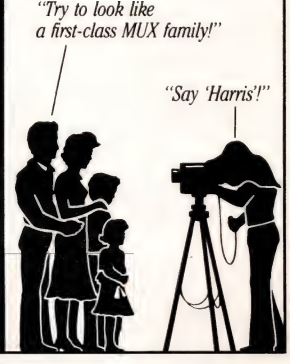

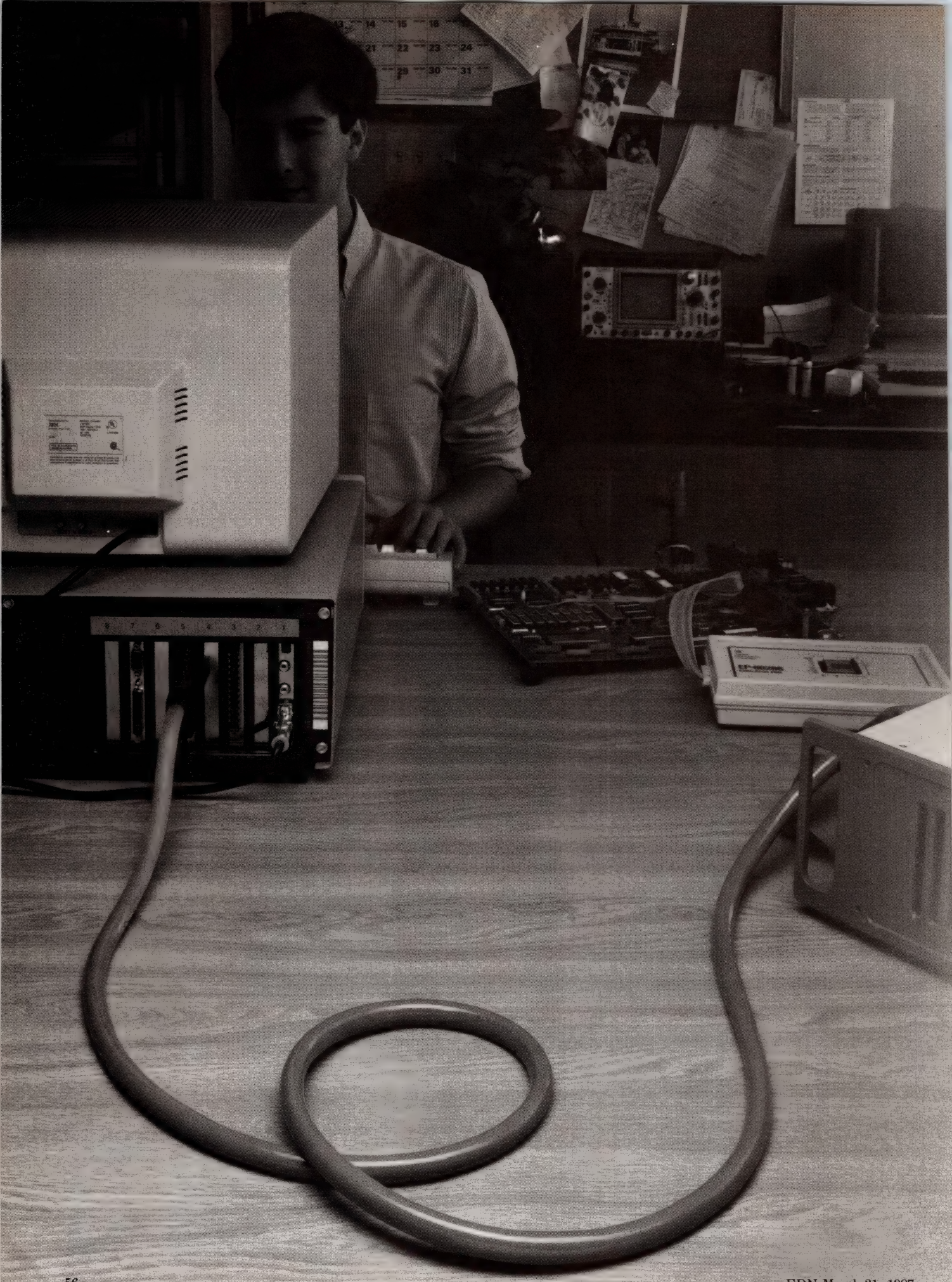

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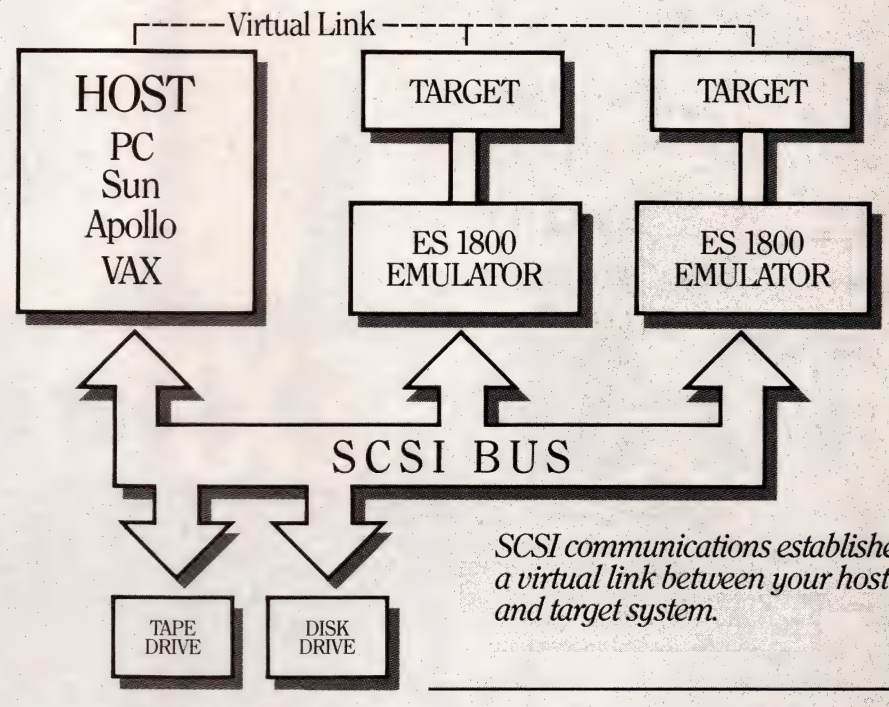

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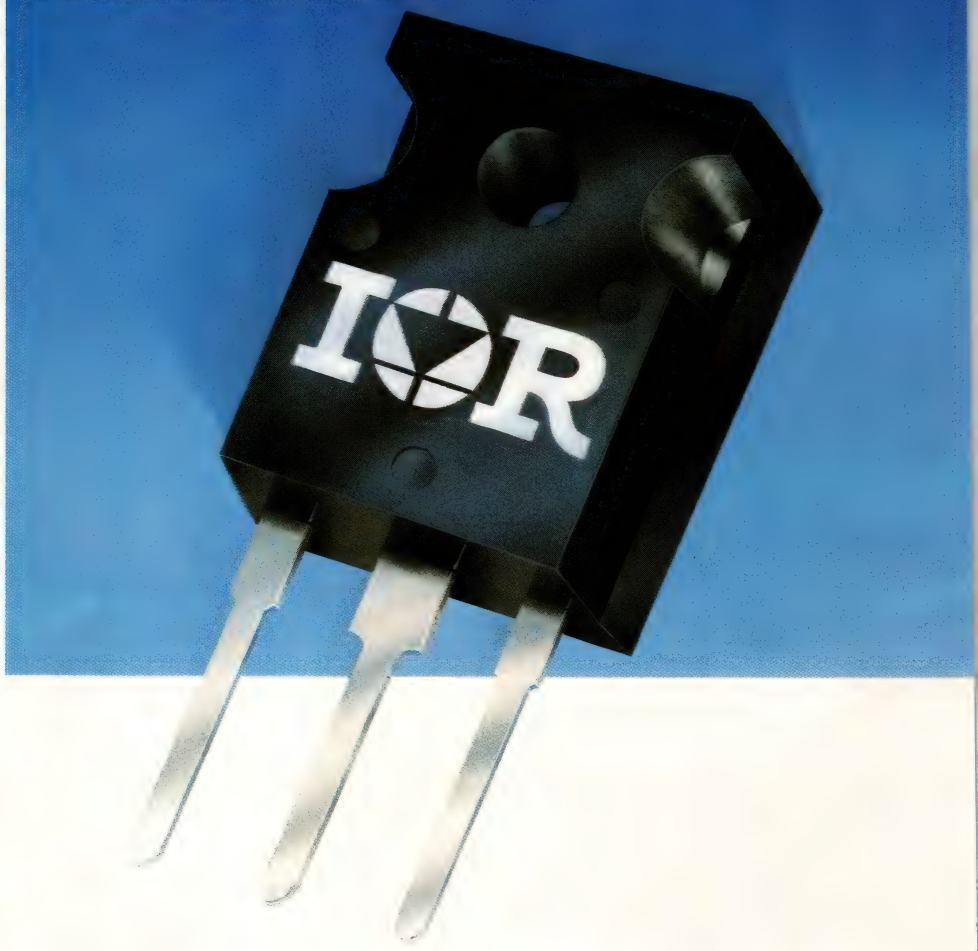

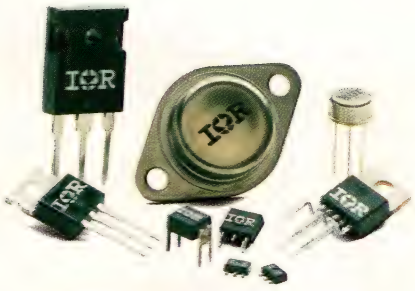

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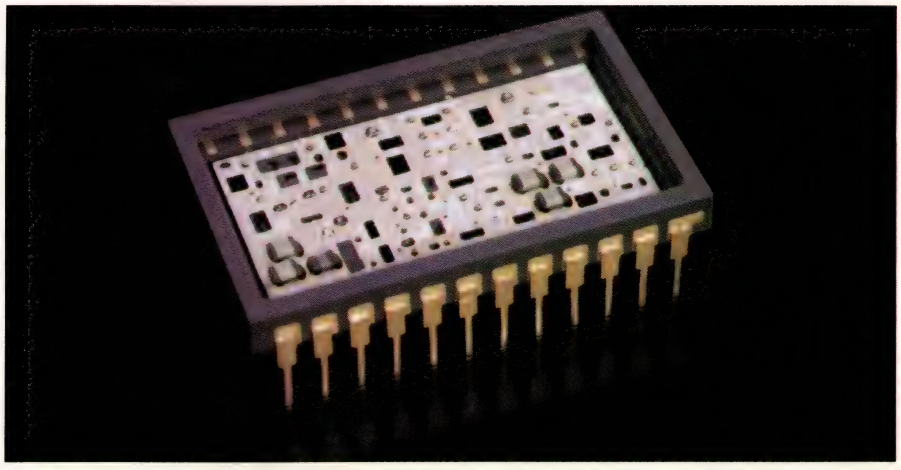
CIRCLE NO 109

Fast A/D converters accelerate the development of sample/hold amplifiers

Tarlton Fleming,
Associate Editor



Able to drive flash A/D converters directly, *this wideband S/H amplifier from Comlinear Corp offers a 16-nsec acquisition time (to ±0.1% of full scale) and has only 1 psec of aperture jitter.*

The news about the latest sample/hold amplifiers will sound familiar to engineering designers, especially those who work with A/D converters: This year's S/H amplifiers are faster, smaller, more accurate, and generally better than last year's models. The improvements in S/H amplifiers follow similar developments in A/D converters, the devices with which S/H amplifiers are most often used. The most noteworthy recent developments in S/H amplifiers include a high-speed hybrid device from Comlinear; a quad S/H amplifier with autocalibration from Crystal Semiconductor; a fast, monolithic device from Signetics that's built with junction-isolated CMOS; and a promising circuit design from Burr-Brown that provides speed without sacrificing linearity.

Sample/hold amplifiers are just as often called track/hold amplifiers, and for good reason: Most of these products can track a signal as well as hold it. A true sample/hold amplifier is incapable of tracking; it samples a signal on command but spends most of its time in the hold mode. But because S/H- and T/H-amplifier manufacturers have yet to converge on a standard definition, this article will apply the term "S/H amplifier" to all sample/hold and track/hold amplifiers.

You can use S/H amplifiers as peak detectors, pulse stretchers, and D/A-converter deglitchers, but their most common application is to provide quasi-dc inputs for an A/D converter. Without a S/H amplifier, the allowable analog bandwidth for an A/D converter's input can be surprisingly low. If you want to achieve 12-bit output accuracy, for example, the highest-frequency signal you can digitize with a 12-bit, 25-μsec converter is 1.55 Hz. By adding an appropriate S/H amplifier, you can operate the converter at its maximum sample rate.

Because S/H amplifiers support the majority of A/D converters in use, it's the converter's performance that dictates your choice of an S/H amplifier. However, many designers regard the S/H amplifier as the key component in a data-acquisition system—if the S/H amplifier can process a signal with adequate fidelity, A/D conversion of the signal is relatively easy to achieve.

S/H amplifiers are inherently troublesome because their operation adds many errors to a signal. What's more, the advent of higher-resolution A/D converters has focused attention on error mechanisms that designers used to be able to ignore. Dielectric absorption in the hold capacitor, for instance, is usually negligible at 12-bit resolution, but at 16-bit resolution it's large enough to be a problem. Further, dynamic errors that arise in converters and amplifiers of higher speed and resolution can dominate your error budget, but the specifications you need to predict these errors are seldom found on traditional data sheets.

You need to choose a S/H amplifier whose specifications are fully compatible with those of the converter you're using. For applications that exercise higher-resolution converters at high sample rates, however, this little task can balloon into a major engineering project.

One solution to the problem is for manufacturers to specify their A/D converters' dynamic performance, so that you can predict the parts' error performance. A few manufacturers have begun to put these specs on their data sheets. Micro Networks has pioneered the use of DSP algorithms in specifying the dynamic performance of its A/D converters. Among the companies that have followed suit are Analog Devices, Analogic, Analog Solutions, and Crystal Semiconductor. By performing fast Fourier transforms (FFTs) on their converters' outputs, these manufacturers determine harmonic distortion, signal-to-noise

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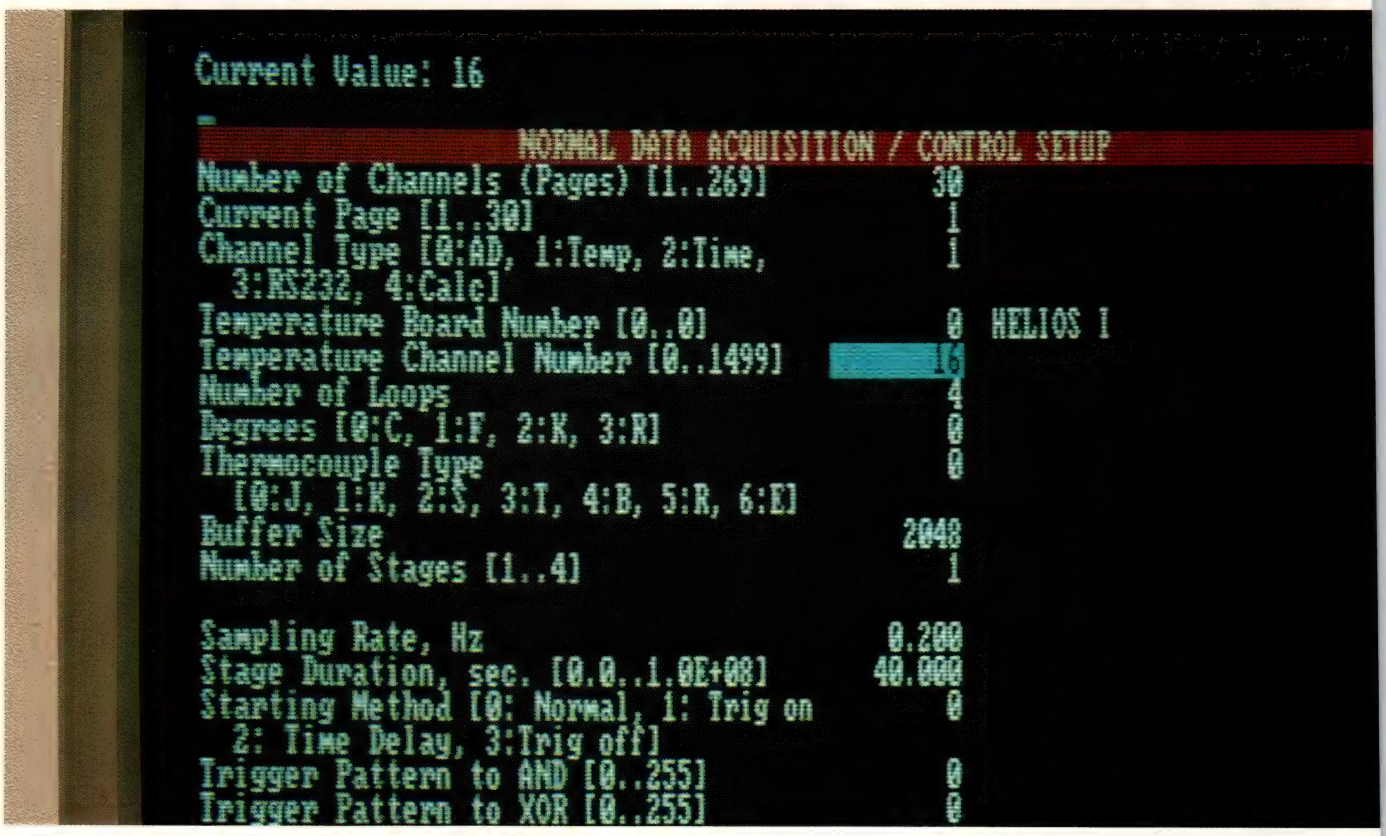

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ratio, and other dynamic parameters.

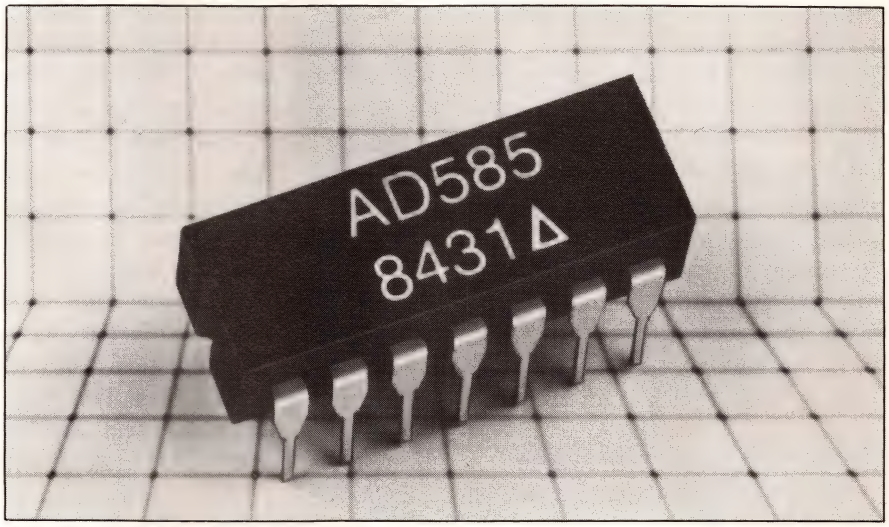
Micro Networks uses the DSP algorithms to specify the dynamic performance of its "sampling converters," a pair of converters that include S/H amplifiers in the converter package. The devices, the MN6227 and MN6228, eliminate your concern about the S/H amplifier by making its operation transparent to the user.

A few other companies offer these user-friendly sampling converters as well, but the typical converter system still combines a stand-alone S/H amplifier with a stand-alone A/D converter. You can choose from a wide variety of S/H amplifiers when designing such systems.

If cost is your main concern, you'll probably want to use the generic 398-type S/H amplifier, a commodity IC offered by AMD, Linear Technology, National Semiconductor, and NEC. Though they're not regarded today as precision parts, these S/H amplifiers suit a lot of applications, and they cost approximately $2.20 (100).

Among the higher-precision ICs is Precision Monolithics' 5-μsec SMP-10FY, which costs $9.50 (100) and suits applications that require 12-bit accuracy. The mature HA-2425-5 from Harris Corp offers comparable speed. Like the HA-2425-5, the most recent monolithic designs from Harris have employed bipolar, dielectrically isolated technology to achieve 12-bit acquisition times of 1 μsec and below. The HA-2425-5 costs $5.19 (100), the 1-μsec HA-5320-5 costs $9.80 (100), and the 0.5-μsec HA-5330-5 costs $15.65 (100).

With the exception of the 398 types, the above S/H amplifiers are all pin compatible. Also pin compatible with these parts is a recent introduction from Signetics, the monolithic NE5060. By using junction-isolated bipolar technology, this product achieves a typical 850-nsec acquisition time (to within ±0.01% of full scale, which represents 12-bit accuracy). Like the newer Harris parts, it includes an internal hold capacitor of about 100 pF. The NE5060 also includes two front-end stages in parallel and a multiplexer that selects between them. In the hold mode, the additional stage reduces droop error by forcing the voltage across the S/H switch to be near 0V. The part costs $9.64 (100).



This monolithic S/H amplifier, *the AD585 from Analog Devices, guarantees 12-bit accuracy. It includes a hold capacitor, differential inputs, and user-selectable gains of 1, 2, or −1.*

Analog Devices' monolithic AD585 includes an internal hold capacitor, differential inputs, and application resistors that let you set the overall gain value to 1, 2, or −1. The part provides 3-μsec acquisition time to ±0.01% of full scale, and it has 0.5-μsec aperture jitter, so it can sample a 20V p-p, 78-kHz sine wave with 12-bit precision. Its price starts at $9.90 (100).

Another monolithic S/H amplifier, Crystal Semiconductor's CSC31412, costs $36 (100) and packs a lot onto one chip: It includes four S/H amplifiers with internal hold capacitors, an output multiplexer and two output buffer amplifiers, a μP interface, RAM, and an autocalibration microcontroller that lowers the total error in each channel to ±700 μV max. Crystal offers the CDB31412, an evaluation board containing a socketed CSC31412, for $100.

The CSC31412's four S/H amplifiers have a common control input that commits the quad device to simultaneous-sampling applications, such as sonar, seismography, and the use of optical techniques for measuring flatness. Each S/H amplifier has an 800-nsec acquisition time (to 12-bit accuracy) and an aperture jitter of 0.5 nsec, but the Hold command switches all four amplifiers to the hold mode within 100 psec (the company refers to this 100-psec window as the "interchannel aperture offset"). This spec, along with the low droop rate (±0.007 μV/μsec), helps ensure the acquisition of accurate samples.

The microcontroller can calibrate the chip at any time, at your command. The device disconnects each channel in turn from its external source, internally grounds that input, and measures the resulting output offset. The chip stores this data in RAM and uses it to control a D/A converter that injects compensating charge into each hold capacitor. The calibration cycle takes less than 200 μsec; by calibrating as required after each power-up operation and temperature change, you can maintain 12-bit accuracy over time and temperature.

Hybrid Systems also offers a quad S/H amplifier, Model HS 9704C. This hybrid device provides an output multiplexer, a buffer am-

plifier, and four separate S/H-control inputs. You can tie these inputs together and take simultaneous samples within a 5-nsec window (which is the same as Crystal's interchannel aperture offset). Alternatively, you can tie the analog inputs together and command the chip to sample one signal at intervals you specify. The typical acquisition time for a 20V step to ±0.01% of full scale is 4 μsec. The HS 9704C sells for $75 (100).

Eschew dielectric absorption

The HS 9716K from Hybrid Systems is one of the few hybrid S/H amplifiers whose specs support the operation of A/D converters that have 16-bit accuracy. Its acquisition time to ±½ LSB (±0.0008%, at 16 bits) is 10 μsec max. A compensation network in this device ensures that the error due to dielectric absorption in the hold capacitor will not exceed ½ LSB at 16 bits. The HS 9716K costs $79 (100).

Another S/H amplifier, Teledyne Philbrick's original Model 4860, is an industry standard, particularly for military systems. The device operates with A/D converters of 12-bit resolution or less, and it has an acquisition time of 200 nsec max. Companies offering 4860-compatible parts with variations in performance include Analog Devices, Datel, Hybrid Systems, ILC Data Device, Intech, and Micro Networks. (These companies' S/H amplifier lines include a number of hybrid and modular products that are intended primarily for military applications.)

The 4860-type S/H amplifiers have a sample-mode feedback loop that encloses the S/H-amplifier switch. Consequently, the parts provide good linearity (±0.01%), but limited bandwidth (about 16 MHz). Burr-Brown's SHC600BH, however, achieves both speed and 12-bit linearity by combining an open-loop input circuit with a closed-loop, noninverting output amplifier.

Suitable for use with high-speed, 12-bit A/D converters, the SHC600BH is capable of acquiring samples with 1% accuracy in 17 nsec, or of acquiring samples with 12-bit accuracy in less than 100 nsec. This hybrid device is included as a subsystem in Burr-Brown's modular, 12-bit, 10M-sample/sec A/D converter, the ADC600. The S/H amplifier comprises a fast open-loop input buffer; an S/H switch implemented with a high-speed, low-impedance diode bridge; a hold capacitor connected between the switch output and ground; and the closed-loop output amplifier.

When it receives a Hold command, the SHC600BH's hold capacitor becomes fully charged before the output voltage can settle. This behavior dovetails nicely with the action of a 2-stage (subranging) flash converter such as the ADC600. The S/H amplifier takes a full sample during the converter's first stage of operation, and it presents an accurate output only when neces-

For more information . . .

For more information on the sample/hold amplifiers mentioned in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

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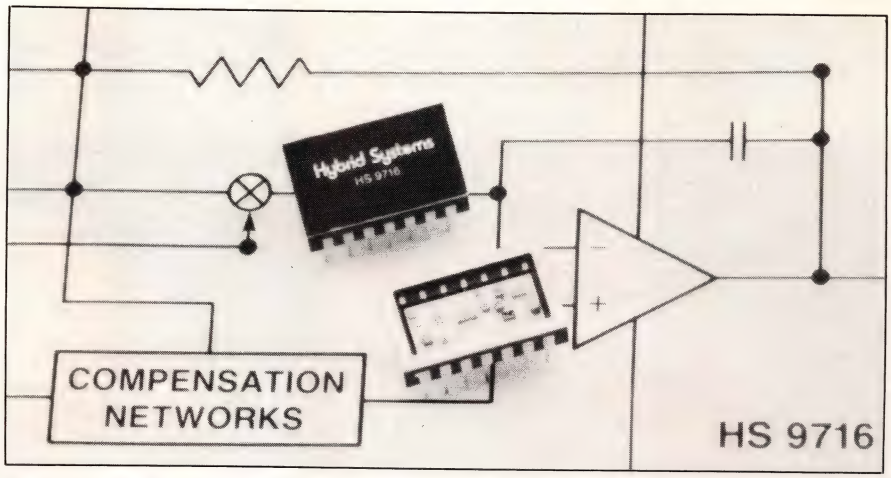
TECHNOLOGY UPDATE



Containing a compensation network *to counter the effects of dielectric absorption in the hold capacitor, the HS 9716 S/H amplifier from Hybrid Systems has 16-bit accuracy and acquires a sample to within 0.0008% of full scale in only 10 μsec.*

sary—during the converter's second, fine-resolution stage of operation. The benefits of this S/H-amplifier architecture have led at least one competitor to surmise that it will become the design of choice of other manufacturers for their future S/H products.

The development of video-speed S/H amplifiers such as the SHC600BH is following that of video A/D converters: As the ADCs achieve higher speeds, S/H amps are doing the same. Venture Development Corp (a Natick, MA, market-research firm) predicts that video and graphics systems will show the strongest growth of all data-converter applications through 1990, so you can expect manufacturers to make continued progress in video-speed S/H amplifiers.

High-speed hybrid S/H amps

Among the fastest commercially available S/H amplifiers are two hybrid parts from Analog Devices and Comlinear Corp. Analog Devices' HTS-0010 and Comlinear's more recent CLC940A are intended for use in radar systems and other high-frequency signal-processing systems, and they're particularly useful for driving flash and subranging A/D converters. The S/H amplifiers have similar circuit topologies. Each achieves high speed (16-nsec acquisition time to ±0.1%, for a 2V step) with an open-loop design consisting of an input buffer, a diode-bridge S/H switch, a hold capacitor connected to ground, and an output buffer. Each amplifier dissipates about 1.65W max and comes in a 24-pin DIP; however, the devices' pin assignments are different.

The HTS-0010KD costs $337 (100) and has the advantage of occupying a large share of the high-speed S/H market. The CLC940AI costs $196 (100), and although it has yet to win wide acceptance, it offers some spec improvements: It has 1-psec aperture jitter, a 150-MHz 3-dB bandwidth, and a 470V/μsec slew rate. For the same parameters, the HTS-0010KD specs 5-psec, 70-MHz, and 300V/μsec, respectively. The Comlinear part also features much improved hold-mode feedthrough rejection: It specs 70 dB min at 20 MHz; the Analog Devices part specs 52 dB min at 10 MHz. The HTS-0010KD, however, settles more quickly after a hold command—it settles in 5 nsec typ, vs the CLC9401A's 12 nsec typ.

Another fast hybrid is Datel's SHM-40MC video S/H amplifier. In this device, the analog signal drives two output buffer amplifiers in parallel. Each output delivers 60 mA typ through separate 13Ω resistors; you can connect these separate outputs externally to increase the drive current and decrease the output

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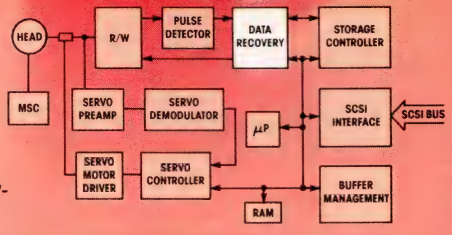

For mass storage disk drive electronics—Silicon Systems supports you best with total "head to host" IC solutions. Example: the Silicon Systems Data Recovery IC family. The flagship of this exciting new series is the SSI 532—the industry's most advanced single chip solution integrating data synchronization and ENDEC functions. Designed as a companion device to the SSI 452 and AIC 010 families of controllers, the 532 is destined to become the industry standard. And for good reason: it offers the type of raw performance and exclusive enhancements that really can separate your hard disk drive from the rest.

Just look at what this space-saver offers: 2,7 RLL encoding/decoding; window symmetry control with μP port for enhanced HDD testability; internal timing elements with a single external resistor to set the data rate; a precision decode window without the requirement of an accurate 1/4 cell delay; 15Mbits/sec. operation; fast acquisition PLL; plus a host of other dynamic features that will give your product the competitive edge.

But the SSI 532 is just one chip in Silicon Systems family of five Data Recovery IC's. Each is optimized for a specific type of drive—one is right for your type of drive. In addition to data recovery, Silicon Systems also offers broad IC families to cover virtually all other functions in HDD and FDD disk drive electronics.

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resistance. The device has a 40-nsec acquisition time to within ±0.1% of full scale for a 2V step, and it has a 40-MHz analog bandwidth and 10-psec typ aperture jitter. It includes a 53-pF hold capacitor and draws 60 mA from ±15V supplies. The part, which comes in a 24-pin DIP, costs $152.

These hybrid S/H amplifiers may see competition from monolithic gallium-arsenide types in the coming year. GaAs S/H amplifiers are fast—you can get as much speed from a single GaAs chip as you can from a multichip silicon hybrid. Anadigics has been evaluating prototype GaAs ICs; the test results as of mid-February promise an 8-nsec acquisition time (to ±1%), a 170-MHz full-power bandwidth for 2V p-p signals, and a 50-mV/μsec droop rate. The devices are compatible with ECL, they operate from ±5V supplies, and they dissipate 0.7W. Mike Gagnon, director of sales and marketing for Anadigics, says the company may introduce two versions of the device this year: one that operates at 200M samples/sec with 8- to 10-bit accuracy, and one that operates at 1G samples/sec with 5- to 6-bit accuracy.

Gallium-arsenide S/H amplifiers are already in use, as Hewlett-Packard's Model HP54111D digitizing oscilloscope demonstrates. The scope can take samples at 1 GHz, thanks in part to a custom, GaAs 4-phase S/H device. Driven by a 1-GHz SAW oscillator, the S/H amplifier routes samples to each of four custom, 6-bit bipolar flash converters operating at 250 MHz. The S/H amplifier updates each converter every 4 nsec. By interpolating between the 6-bit quantization levels, the system can provide an effective resolution as high as 8 bits. **EDN**

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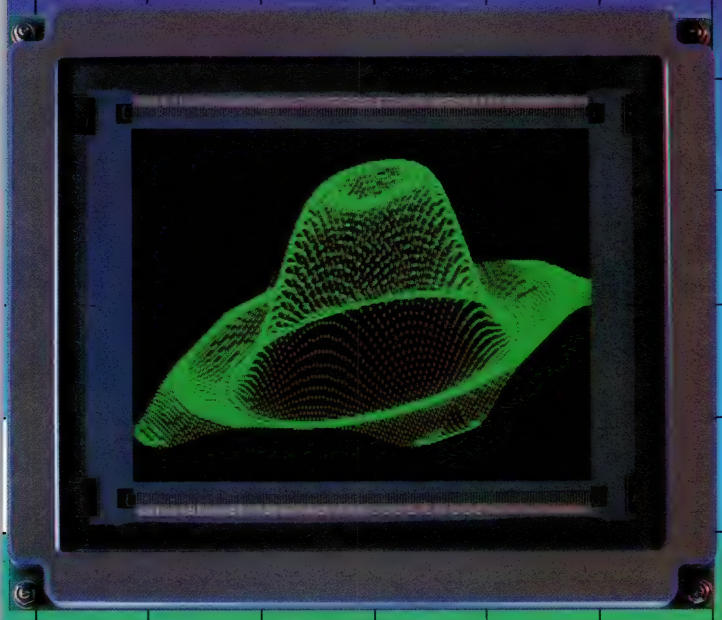
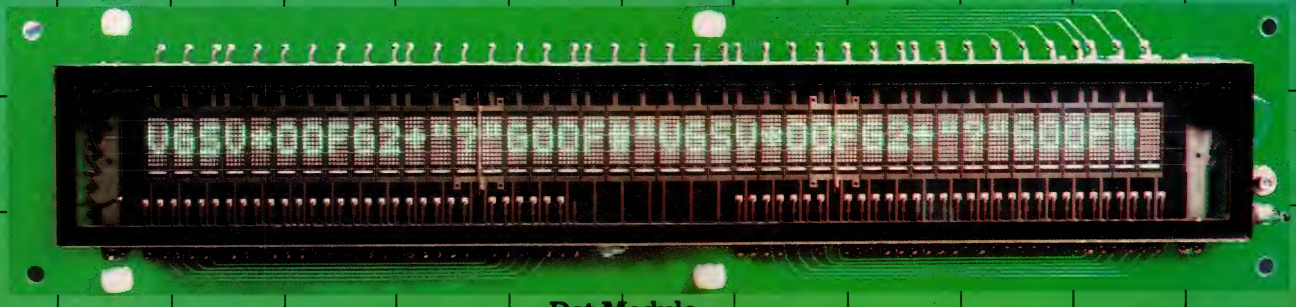
(Circle One)
High 515 Medium 516 Low 517

Clear and Bright

Vacuum Fluorescent Technology



Graphic Module



Dot Module

FEATURES

1. High resolution and high brightness provides excellent appearance and quality.
2. Light weight and thin package permits compact design.
3. TTL compatibility provides easy interface and self-test and brightness control are standard features.

Graphic Module Series List

Type code	Number of Pixels row × column	Pixel Pitch mm	Effective Display Area mm	System	Alphabetic Display digit × col
GP1005	128 × 64	0,65	83 × 41,4	VFD	20 × 6
GP1006	256 × 64	0,65	166 × 41,4	VFD	40 × 6
GP1009	240 × 64	0,45	107,9 × 28,7	VFD	40 × 6
GP1001	320 × 120	0,375	120 × 45	FLVFD	52 × 12
GP1002	320 × 240	0,375	120 × 90	FLVFD	52 × 24

Inquire for single color Graphic Module

Dot Module Series List

Type code	Characters × Line	Dot Construction	Character Size	Nos. of displaying characters
M20SD01CA	20 × 1	5 × 7 dot	3.5 × 5.0	222
M20SD42CA	20 × 1	5 × 12 dot w/cursor	3.5 × 8.75	222
M40SD02CA	40 × 1	5 × 7 dot w/cursor	3.5 × 5.0	222
M40SD42CA	40 × 1	5 × 12 dot w/cursor	3.5 × 8.75	222
M202SD03CA	20 × 2	5 × 7 dot w/cursor	3.5 × 5.0	222
M402SD04CA	40 × 2	5 × 7 dot w/cursor	3.5 × 5.0	222

Inquire for single color Dot Module

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8Kx8 = 35ns

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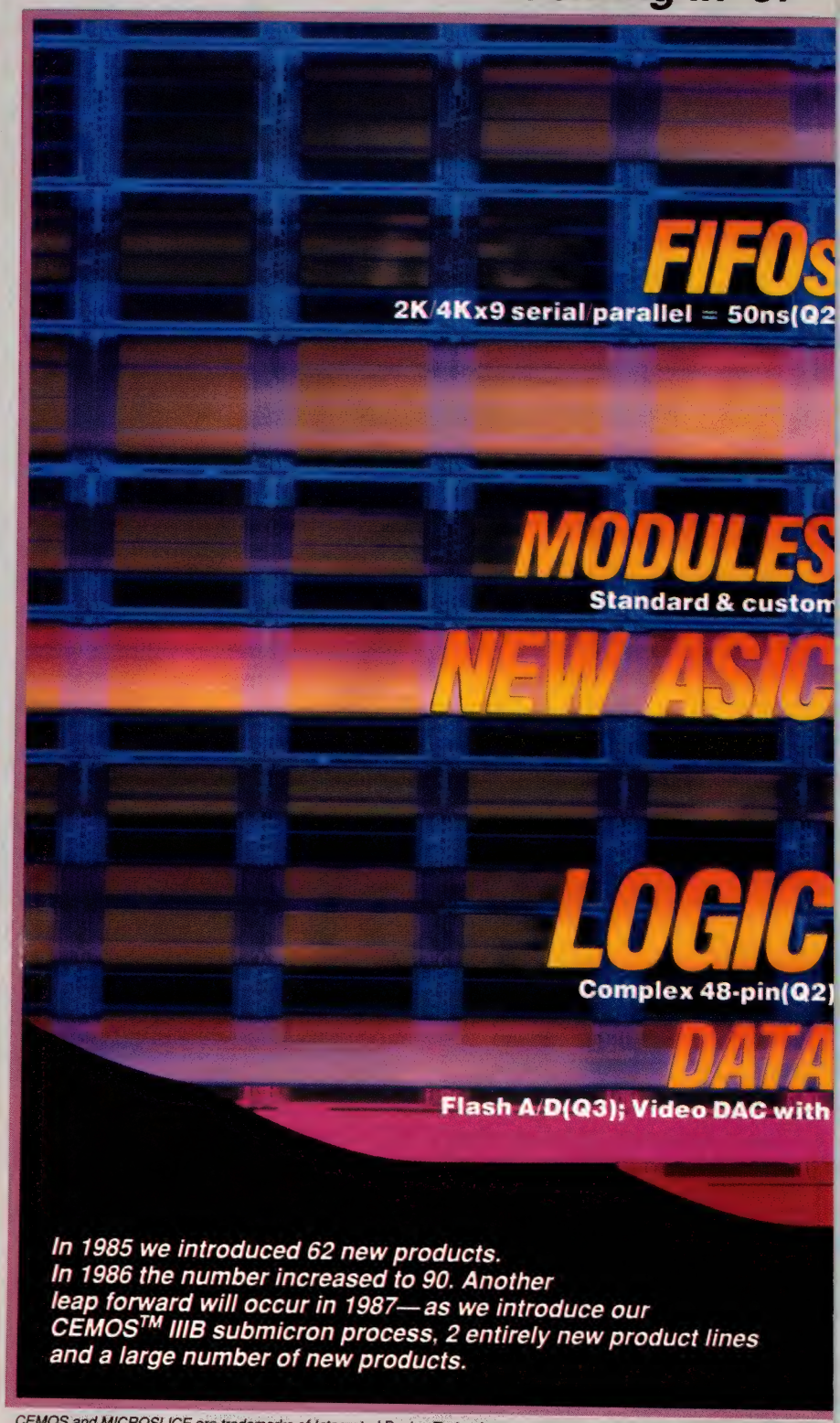

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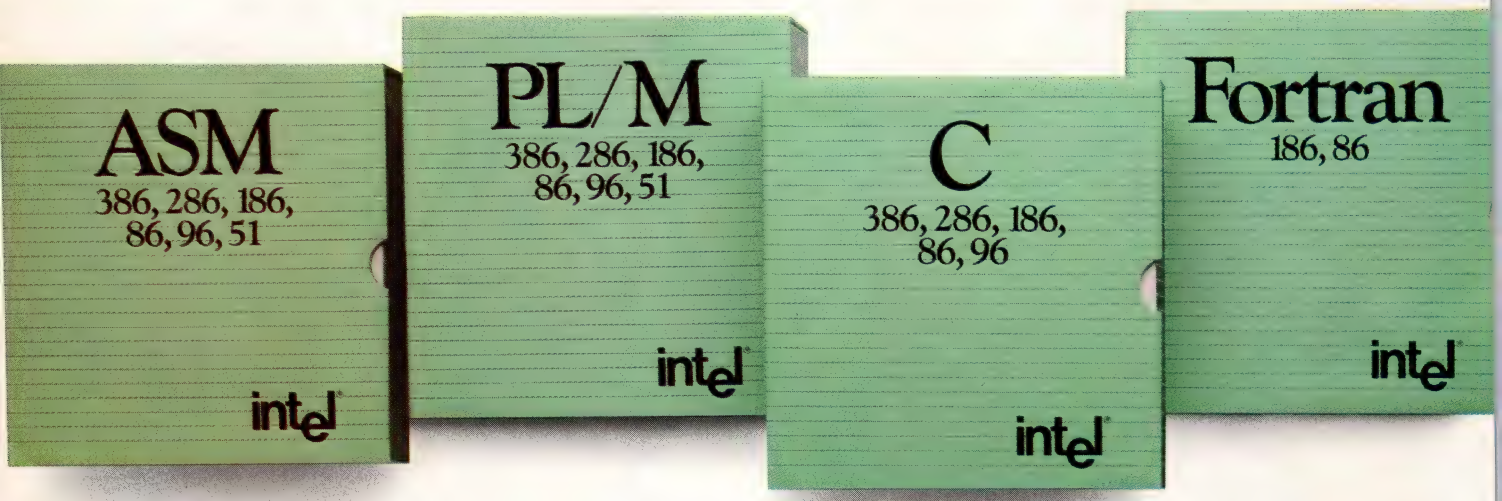

If you develop software for any product based on an Intel microcontroller or microprocessor, including the 80386, the unique debug hooks in the Intel languages will help get the job done faster.

In fact, when used with Intel debuggers and emulators, Intel development languages can provide more debug data than any other high-level language.

Debug hooks let you symbolically debug in the same high-level language you wrote in without having to deal with machine or hex code. Which means 80.386 reads as 80.386, not 50 62 D0 C5.

Because the location of both code and data are easily specified with our locator, it is easier for you to develop ROM-based firmware.

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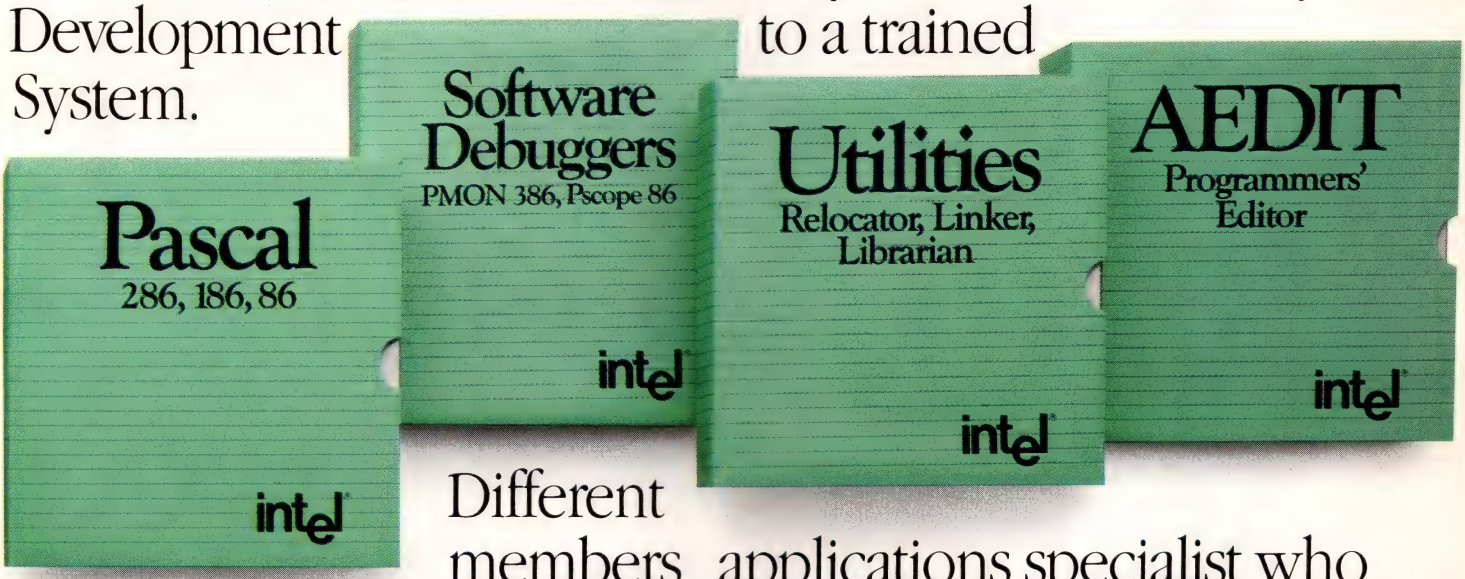

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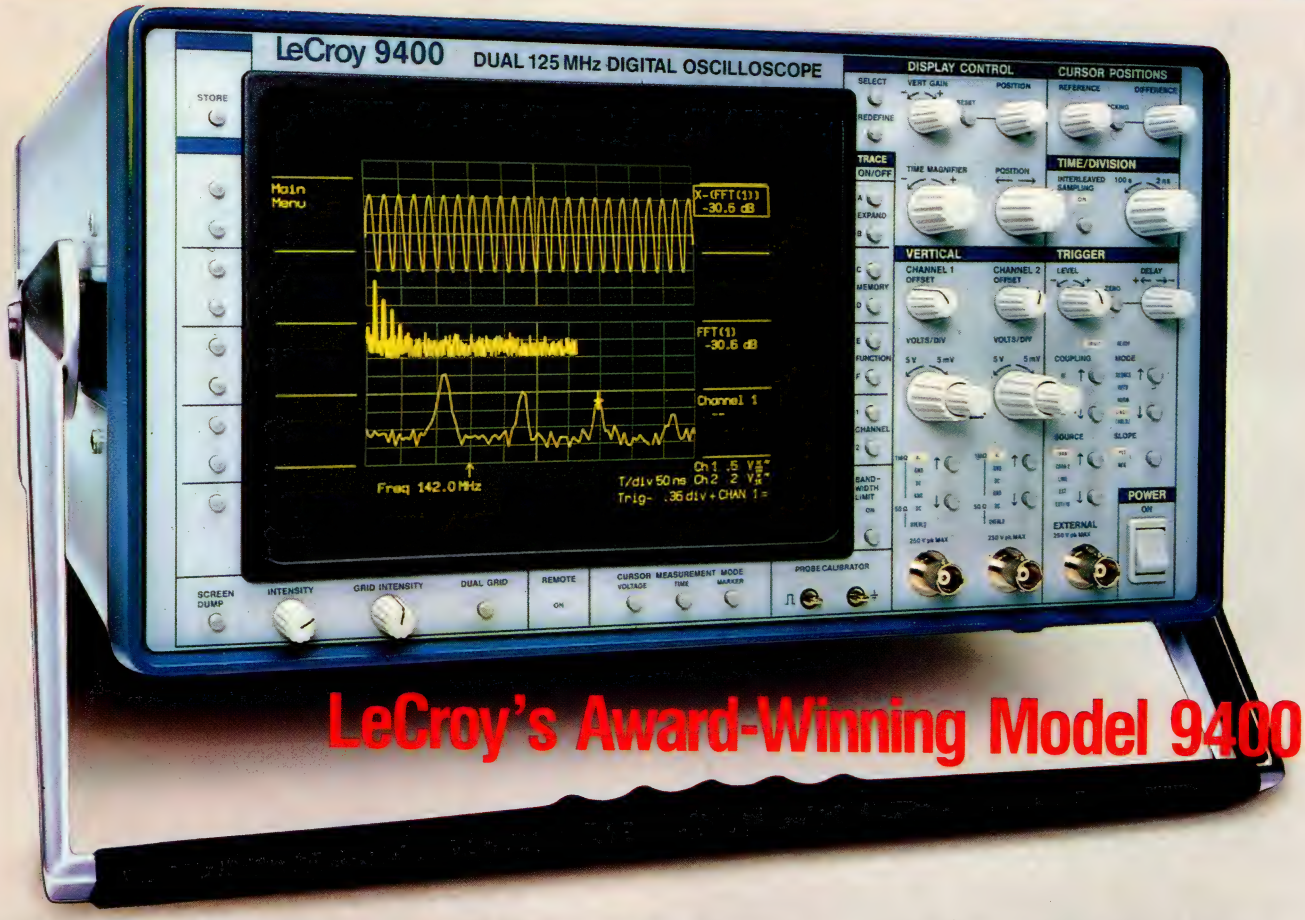
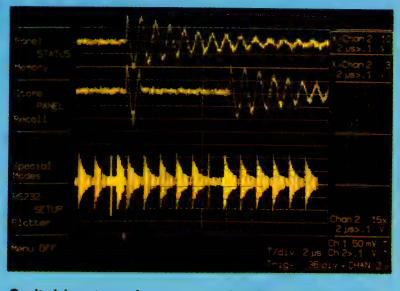
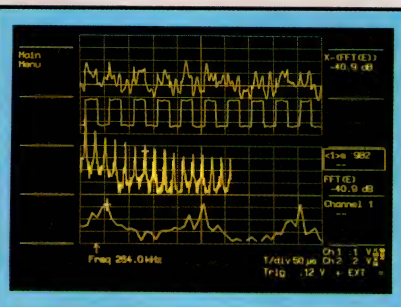


LeCroy's Award-Winning Model 9400

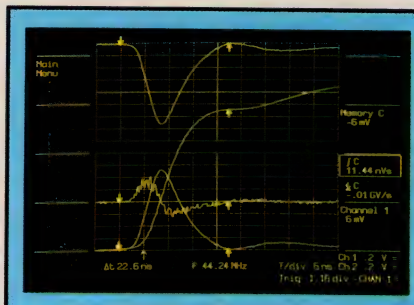
- **Bandwidth in Excess of 125 MHz. 100 MS/S Digitizing Rate. 5 GS/S Random Interleaved Sampling Rate.**
- **8-Bit Vertical Resolution.**
- **32K Segmentable Acquisition Memories, Each Channel. Up to 192K Total Memory.**
- **±1% DC Accuracy. Autocalibration.**
- **Fast Fourier Transforms 50-25,000 Points. FFT Frequency Resolution; 1 milliHertz to 50 MHz.**
- **Signal Averaging in Time and Frequency Domains to 1,000,000 Sweeps.**
- **Digital Filtering and Extrema Mode.**
- **Fully Programmable Via GPIB and RS-232.**
- **Waveform Processing Mathematics: Integration, Differentiation, Arithmetics.**



Switching transients recorded in segmented memories show contact bounce in segment number 3. Cursors can measure bounce-time-interval precisely.



Noisy R.F. Transmission Signal is averaged in time domain. Spectral content of cleaned-up signal is analyzed by FFT.



Inverted photo-diode signal is normalized then integrated for energy measurement (area under curve =11.44 nVs). Differential dC/dt is shown as well.

...Signal Processing in Both the Time and Frequency Domains!

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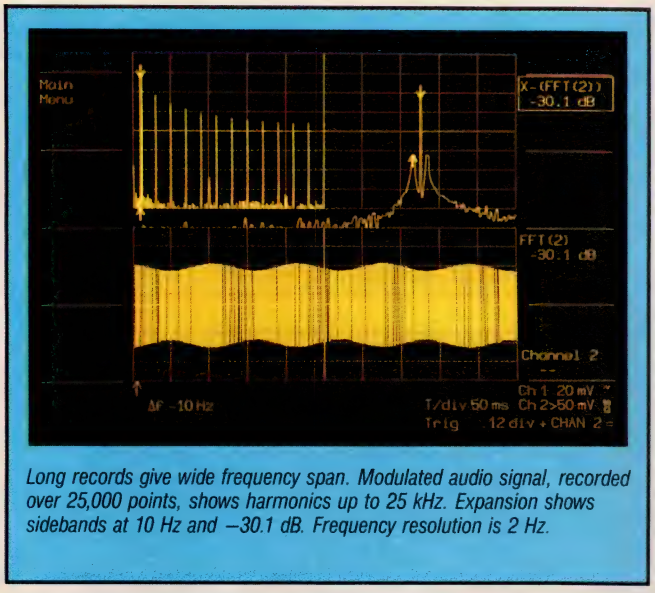
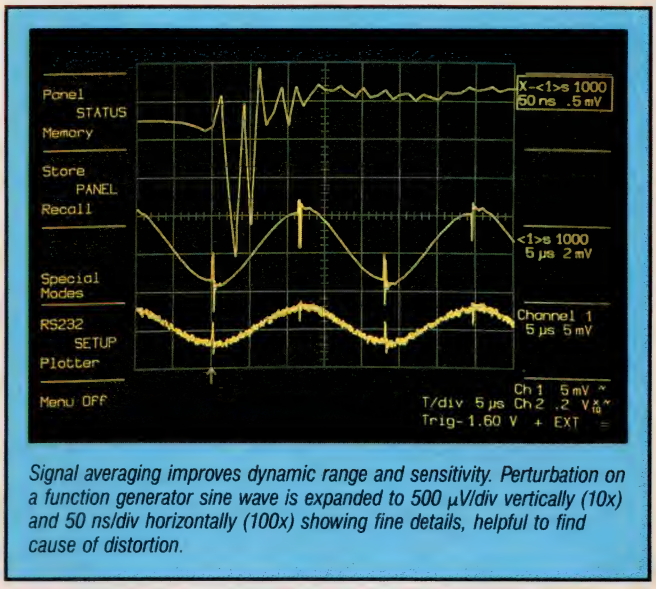
LeCroy's Model 9400 Digital Oscilloscope offers you more waveform measurement capability, more signal analysis power, longer memories and higher precision than any other digital scope. Here's how:

Start with wideband, dual-channel, simultaneous signal acquisition at 100 MS/S and a 5 GS/S random interleaved sampling rate with unmatched DC accuracy of ±1%. Add a full complement of waveform processing mathematics and then offer more memory capacity than any other scope, like 192K! Memory that can be segmented into smaller sections allowing you, for example, to store up to 250 waveforms per channel for individual analysis and comparison.



Long records give wide frequency span. Modulated audio signal, recorded over 25,000 points, shows harmonics up to 25 kHz. Expansion shows sidebands at 10 Hz and −30.1 dB. Frequency resolution is 2 Hz.

And now, with Fourier Processing, you can examine the frequency constituents of your processed time-domain data over a **WIDER** range and with **MORE** resolution than has ever been possible before with any other **portable digital scope!** The 50-25,000 point FFT variable transform size provides unequalled resolution from 1 milliHertz to 50 MHz. Large transform size FFT's yield better and faster signal-to-noise improvement than signal averaging and enable you to separate closely-spaced frequency components for detailed analysis without an external computer. Multiple, menu-selectable display options present your spectra in familiar formats, such as power spectrum, power spectral density (PSD), real and imaginary, or magnitude and phase. And, with this versatile scope, you can instantly change displays or look at the same data in different formats **without changing setups.**



Signal averaging improves dynamic range and sensitivity. Perturbation on a function generator sine wave is expanded to 500 µV/div vertically (10x) and 50 ns/div horizontally (100x) showing fine details, helpful to find cause of distortion.

And the 9400 has many more outstanding features! Unique features such as **summation** averaging up to 1,000,000 signals with offset dithering to increase the effective resolution by several bits. And, **continuous** (exponential) averaging with multiple weighting factors so you can quickly and easily minimize the effects of noise on your measurements. Do you have a time or amplitude drift problem? In its unique **EXTREMA** mode, the 9400 precisely tracks and records all extreme positive and negative values including glitches and spikes as short as 10 ns. And with its comprehensive waveform processing, the 9400 offers many powerful routines for performing signal characterization, mathematical analysis and post-processing of waveform data.

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Affordable image scanners and software simplify the design of imaging systems

Maury Wright, *Regional Editor*

Now you can choose from image scanners in a variety of configurations and design a low-cost imaging system. More to the point, you have the opportunity to be creative: You'll be surprised at the applications that are possible. Although most low-cost systems scan relatively small (letter- and legal-size) areas, large-scale scanning is now also feasible.

A complete low-cost system can consist simply of a personal computer, a scanner, and controlling software. Scanner vendors offer some software and development tools, but you may still have to write custom code for your application.

When you consider a scanner, the following tangible specs will affect your decision: mechanical configuration, scan-area size, resolution, scan speed, gray-scale and halftone support, and hardware interfaces. Harder-to-quantify considerations, such as the amount and type of manufacturer software support, data-file format, and third-party hardware/software support, will also influence your choice of system design and scanner. You may be swayed by special features such as color scanning, or you might opt for placing a digitizing head on a standard printer or plotter for a really low-cost implementation.

The Truscan overhead scanning system, *manufactured by Truvel, has a scanning resolution of 900 dots/in. over a 4×6-in. area.*

Scanners provide a bit map

Despite differing electrical and mechanical configurations, all image scanners perform basically the same function (see **box,** "Image scanners 101"). They simply digitize an image and provide a bit map of the image to a host computer. Some provide limited processing capability of the scanned data, but most depend on host-resident software to manipulate an image.

Much of what you may have read or seen in advertisements about scanners may be misleading as to the function they perform. You may have seen scanners referred to as OCR (optical character recognition) scanners, image scanners, or OCR/image scanners. Actually, the adjective modifying the word "scanner" refers to the software that a vendor includes in the package.

Microtek offers both types of software. The $2495 sheet-fed MS-300A and the $2000 flat-bed MSF 300 come with IBM PC-compatible software called Eyestar for capturing and manipulating images. Optional OCR software, called Readright, costs $695.

Both scanners spec 300-dot/in. resolution max, scan a maximum 8½×14-in. area, and scan letter-size documents in just under 10 seconds. Each includes an IBM PC-compatible parallel-DMA interface card; for the Macintosh, you can choose a SCSI interface and Versascan software.

Bit map uses one bit/pixel

The Microtek scanners are capable of reading one bit/pixel from an image. They employ a D/A converter and produce a threshold voltage by varying the brightness and contrast levels; this threshold voltage is

side view
(actual size)

With a Planar light-emitting electroluminescent flat panel display, you could use the rest of this space for anything you like. Call either 503-690-1100 or 503-690-1102, or write for a brochure:
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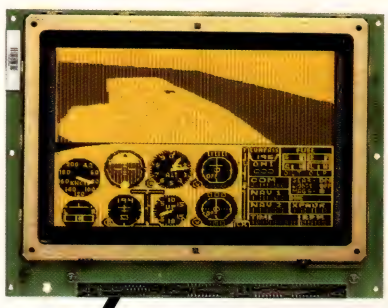

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compared to the voltage produced by each CCD element to determine black and white pixels. By changing the threshold level, the scanners produce halftone images. The MS-300A offers 14 brightness and 14 contrast levels; the MSF300 offers three of each. Microtek plans to introduce a scanner with gray-scale capability this year.

OEMs that buy from Microtek get software support—and of course a lower price for buying in quantity. Microtek supplies the source code to Eyestar or will help you modify Eyestar for a given application.

For example, AST Research (Irvine, CA), a Microtek customer who buys the MS-300A for sale in turnkey desktop-publishing applications, modified Eyestar to provide fast-scan and -output capabilities to its laser printer. For your application, you may not need the image-capture and manipulation capabilities of Eyestar; nonetheless, the scanner-driver software embedded within Eyestar will save you from having to develop drivers.

This scanning system, the Scanmaster *from Howtek, employs a single-pass scanning technique with separate red-, green-, and blue-filtered light sources.*

Vendors provide drivers

Another company that provides software support is Datacopy, a vendor of sheet-fed, flat-bed, and overhead scanners. Datacopy is willing to assist OEMs in tailoring a scanner to an application and will provide source code to aid the development process.

All Datacopy scanners are available with software suitable for personal computers. WIPS (word image processing system) software, PC Image, and OCR Plus run on IBM PCs and compatibles, and MacImage runs on the Macintosh. WIPS is a basic image-scanning package that also provides you with the ability to merge images in a document produced with a standard word processor. Both PC Image and MacImage are specifically targeted at the desktop-publishing market and work in conjunction with most desktop-publishing packages.

OCR Plus includes standard character-recognition software and an integrated character-learning facility. Most OCR software recognizes characters based on matching the pixels or patterns of the character in question with characters in a given font set. OCR Plus performs such tasks, yet can also learn new font sets using artificial-intelligence techniques.

Besides providing software support and development aid, Datacopy is also a proponent of standardization in the graphics industry. The company has seen the problems involved in transferring incompatible data to raster devices (such as laser printers), and it hopes to clear up confusion in the areas of host file format and host scanner control.

TIFF specifies data format

For example, Datacopy has been instrumental, along with Aldus (Seattle, WA), Microsoft (Redmond, WA), and Dest (Milpitas, CA), in standardizing the way image data is stored. The TIFF (tag image file format) specifies a file format that organizes and codes the definition and use of digital image data. If all scanner and software vendors adopt TIFF, any scanner will be able to work with any software, and any application program will be able to share digital image files. Datacopy plans to implement TIFF in all its scanner products but will also support other file formats predating TIFF.

Datacopy has also proposed a procedural language to control overall scanner operation. This high-level language, Prescript, defines functions and algorithms to control such operations as inverting and scanning as well as many others. Prescript is intended to provide host-software developers with a simple interface to intelligent scanners.

In reality, scanners capable of implementing Prescript will require more local intelligence than any scanners currently available. So, although Datacopy hasn't implemented Prescript yet, it hopes to have a product for sale by midyear. The company actually buys its scanner engines from Ricoh, and the two vendors are working together to develop an intelligent engine. Datacopy has placed Prescript in the public domain, and it offers third-party support, including a specification and user's manual.

As far as current products are concerned, Datacopy sells the $1800 flat-bed Model 730 and the $1300 sheet-fed Jetreader. These scanners each offer a 14-sec scan speed for an

8½×14-in. document scanned at 300 dots/in. They discern 16 levels of gray scale and therefore represent an image with four bits per pixel. And because they can read gray scale, they can produce a variety of halftone patterns.

Kit includes interface

The prices quoted for these two scanners cover the cost of the engine only, but you can purchase a kit with a host interface and software. As an example, a kit including either PC Image or MacImage, a paintbrush program, and a parallel interface for IBM PCs and compatibles (or a SCSI interface for the Macintosh) costs $695.

Because Ricoh manufactures the scanner engines that Datacopy uses, you can buy the scanners direct from Ricoh. The IS30-M2 flat-bed model costs $1900, and the SS30 sheet-fed unit costs $1300. Although these prices are comparable to Datacopy's, you may be able to get a better price by buying from Ricoh in large quantity. Datacopy offers more hardware/software support, though. Ricoh does supply OEMs with the ISI-80, an IBM PC-compatible interface card for $550 (this price includes a basic set of software drivers), but Ricoh doesn't offer a complete software package.

Several other computer-peripheral manufacturers also plan to participate in the low-cost, high-volume scanner business. Panasonic, for instance, began shipping evaluation units of its flat-bed FX-RS505 scanner in January. The device features selectable resolutions of 200, 300, and 400 dots/in., and it discerns 16 levels of gray. Panasonic plans on selling the unit for around $1300 but hasn't yet decided about packaging software with the unit. Canon is another vendor that offers scanner products to OEMs.

If you don't mind spending more money, you can buy a system capable of scanning larger documents faster. Ricoh sells a flat-bed unit for $5800. The IS400 handles A3-size (11.7×17-in.) documents, specs 400-dot/in. resolution max, and discerns 64 levels of gray.

The scanners discussed thus far, and most scanners suitable for letter- and legal-size document scanning, typically specify 3- to 30-sec scan times. Whereas your scanner engine may be capable of such speeds, your PC may well not be. The times specified reflect a continuous scan with data flowing nonstop to the host computer. Any processing you ask the scanner to do may slow down the actual scanning. More significantly, the inability of your host to swallow data fast enough may slow down the scan.

For example, an IBM PC/XT with a 60-msec Winchester and 640k bytes of RAM requires about two minutes to scan an entire image; the scanner must stop and wait for the personal computer. This very problem has, in fact, hampered the popularity of scanners. They provide too much data faster than today's generation of personal computers can handle.

Data requires compression

If the bit map inside the computer represents an image with one bit per pixel, it would require almost 8.5M bits to represent a letter-size document. Multiple bit/pixel representations raise the number of required bits even more. The sheer magnitude of this data mandates the use of data compression and high-speed parallel links between scanner and host. The host must either store the image in RAM or in a mass-storage system.

Some scanner and third-party manufacturers have addressed the problem of handling large amounts of data. Advanced Vision Research manufactures a scanner and combines it with an IBM PC-compatible scanner controller and 1.3M-byte memory card. The flat-bed Page-

For more information . . .

For more information on the image scanners discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Advanced Vision Research Inc
1943 Hartog Dr
San Jose, CA 95131
(408) 436-5566
Circle No 701

Canon USA Inc
1 Canon Plaza
Lake Success, NY 11042
(516) 488-6700
Circle No 702

Datacopy Corp
1215 Terra Bella Ave
Mountain View, CA 94043
(415) 965-7900
TLX 701994
Circle No 703

Epson America Inc
Computer Products Div
2780 Lomita Blvd
Torrance, CA 90505
(213) 539-9140
Circle No 704

Galileo Electro-Optics Inc
Galileo Park
Sturbridge, MA 01518
(617) 347-9191
TLX 4999014
Circle No 705

Houston Instrument
Div of Ametek Inc
8500 Cameron Rd
Austin, TX 78753
(512) 835-0900
TLX 776438
Circle No 706

Howtek Inc
21 Park Ave
Hudson, NH 03051
(603) 882-5200
Circle No 707

Microtek Lab Inc
16901 S Western Ave
Gardena, CA 90247
(213) 321-2121
TLX 797880
Circle No 708

Panasonic Industrial Co
Computer Products Div
2 Panasonic Way
Secaucus, NJ 07094
(201) 348-7000
Circle No 709

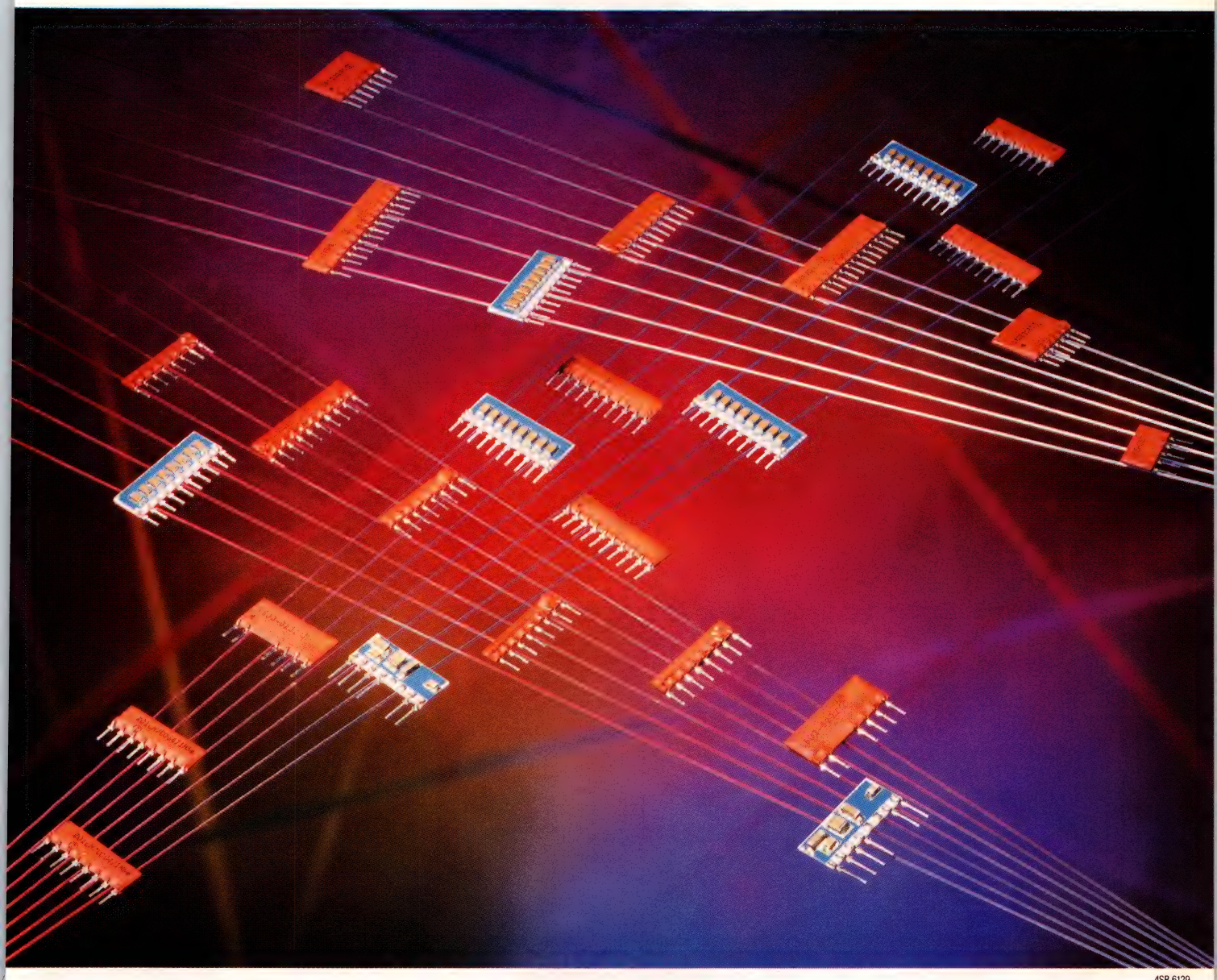
Ricoh Corp
Peripheral Products Div
155 Passaic Ave
Fairfield, NJ 07006
(201) 882-2000
TLX 752930
Circle No 710

Sharp Electronics Corp
Systems Div
Sharp Plaza
Mahwah, NJ 07430
(201) 529-9500
TLX 134327
Circle No 711

Tall Tree Systems Corp
2585 E Bayshore Rd
Palo Alto, CA 94303
(415) 493-1980
TWX 910-240-4041
Circle No 712

Truvel Corp
2808 Oregon Ct, Suite K-2
Torrance, CA 90503
(213) 533-4971
Circle No 713

NETWORK NEWS.



4SR-6129

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Sprague Electric Company, a Penn Central unit, Lexington, MA. For applications assistance call our Customer Service Center at 603/883-9774. For our Thick-Film Networks Catalog RN-126, write to Technical Literature Service, Sprague Electric Company, P.O. Box 9102, 41 Hampden Road, Mansfield, MA 02048-9102.

SPRAGUE
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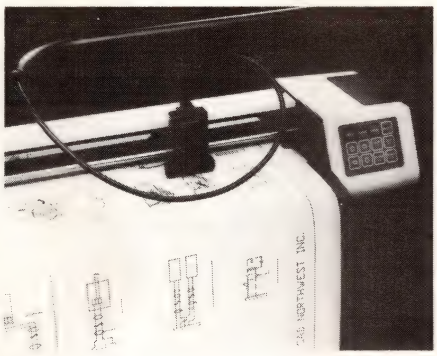
CIRCLE NO 181

master scanner and the Megabuffer controller can digitize an 8½×11.7-in. page in nine seconds. The scanner, controller/memory card, and image-processing software cost $2495.

In addition, the company sells its $395 Multiple Device Adapter, which links together the scanner, the memory, and any laser printer based on Canon or Ricoh engines. By bypassing the normal laser-printer controller, the Multiple Device Adapter lets you print images as fast as you scan them.

Although Tall Tree Systems doesn't actually manufacture image scanners, the company offers JLaser Plus IBM PC/XT- and PC/AT-compatible cards that interface to scanners using Ricoh or Canon engines and to laser printers using Ricoh or Canon engines. The PC/XT version costs $599; the PC/AT version sells for $699 (excluding any memory). You can add 2M bytes of EMS-compatible (extended memory specification) memory. Quite a few graphics application packages support these boards.



Scanning E-size documents with a plotter *and an attached scanning head reduces the cost of large-size scanning applications. An owner of a Houston Instrument DMP-50 Series plotter can add the Scan-CAD scanning head for $3000.*

The problem of transferring data is compounded when you have a color image scanner. Color-sensitive scanners generate an even bigger mass of data to send to the host because they store red, green, and blue planes of data.

The Sharp JX-450 has one CCD and separate red-, green-, and blue-filtered light sources. The scanner resolves eight bits per pixel but only guarantees 6-bit accuracy. The six bits per pixel provide 64 levels of gray scale for red, green, and blue separations. As yet, the company doesn't have any device drivers for this 300-dot/in. $5995 scanner.

Howtek, however, sells the Sharp scanner with source code for device drivers. The library of C functions provides an interface to MS-DOS, Unix, and some DEC operating systems. The scanner comes with a GPIB interface; Howtek plans to offer configurations for the IBM PC

Image scanners 101

All digitizing image scanners provide a host computer with a bit map that represents an image, and all scanners use an array of light-sensitive devices to detect the light reflected from that image. Ordinarily, a scanner employs a CCD (charge-coupled device) to sense light, but a few use linear photodiode arrays.

A CCD generates an analog voltage corresponding to the intensity of light striking a given element. A typical CCD includes elements spaced about 8 μm apart, and thus a 1-in. CCD array can contain more than 3000 elements. An image scanner must include some type of a lens to collect the light reflected from an image and focus the light in an image plane directly in front of the CCD elements. The lens is required because a CCD packs a much greater number of elements per inch than a 300-dot/in. scan resolution.

Scanners fit one of three configurations

The mechanical configurations of most scanners fall into one of three categories: overhead, flat-bed, or sheet-fed. Overhead systems employ a flat scanning surface with the sensing device mounted on a stand. They use typical 35-mm camera lenses to focus light from the image at the CCD.

Flat-bed systems function similarly to many copy machines. A document rests face down on a glass plate, and a flap covers the document. Within the scanner, a light source and CCD array move under the image to digitize lines of data. In some flat-bed scanners, the CCD is fixed, and a mirror assembly moves with the light source to channel the image to the CCD array. Typically, flat-bed scanners offer better results than do sheet-fed models, which introduce some amount of paper skew when moving a document past the CCD. The skew can cause horizontal lines to appear jagged.

Sheet-fed systems move paper past a fixed CCD and light source. The mechanism for moving paper around a platen and past the sensor is inherently simpler than the mechanism required to move the light source and CCD. Sheet-fed devices will accept a single hand-fed document; some incorporate paper trays for multiple sheets.

A scanner digitizes one line of an image at a time; this line consists of a single row of picture elements, or pixels. Most applications are satisfied with resolutions in the 300-dot/in. range, but with some scanners you can get substantially higher or lower resolution. To digitize multiple scan lines of an image, a scanner must either move the image (paper) past the CCD or move the CCD in relation to the image. Normally, scanners digitize lines at

bus, VME Bus, Multibus, Q Bus, and Unibus.

The vendor calls its version Scanmaster and sells it for the same price as Sharp. In addition to color-scanning capability, the unit performs perfectly well on monochrome images and includes more intelligence and image-processing capabilities than most other scanners.

If you're familiar with image scanners, it's probably because you've seen them used in desktop-publishing or office-automation applications. The scanners covered in this article do fit these applications, but they also serve a limitless number of other applications. In addition to using image scanners to capture engineering drawings for CAE/CAD use, you can design them into systems to automate operations in the factory, the design room, and the office.

For example, flat-bed scanners can provide digitized images of pc-board artwork. You can check the artwork with the zoom facility of the image-scanning software before beginning to build the boards. In fact, you can use scanners to help automate many inspection tasks.

Overhead scanners prove particularly versatile for inspection applications. Older overhead scanners cost $20,000 or more, but you can now buy a unit for as little as $5000. These types of scanning systems are more complex than the sheet-fed and flat-bed models, though. You must manually set the zoom and focus of the lens and scanner. Also, the scanner must incorporate features to compensate for the difference in CCD elements and essentially allow for calibration.

Truvel's Truscan unit scans 3600 pixels/line and accommodates documents as large as 12×18 inches. The stand, which holds the scanner's linear CCD array, moves to generate multiple scan lines and also holds fluorescent tubes that light the image. These tubes aim light directly at the line being scanned and eliminate the need to floodlight the entire image, which is what other overhead systems require.

The Truscan scanner has a 35-mm zoom lens that allows you to change resolution. At its full 12-in. scan width, the scanner provides 300 dots/in.; over a 4×6-in. area, this figure increases to 900 dots/in. You can vary the number of lines/inch scanned by varying the scan speed. For instance, you can scan legal-size documents at an asymmetrical scan rate (more lines/in. than dots/in.) and store or print them as letter-size documents.

The unit comes with either an

the same rate that they digitize dots. For example, if a scanner digitizes 300 dots/in. per line and operates at a 300-lpi (lines/in.) scan rate, the result is a symmetrical 300-dot/in. aspect ratio of pixels.

The number of elements in the CCD and the width of the scan line determine the true maximum resolution a scanner can produce. Most low-cost scanners have a fixed scan-line width, although a few devices essentially vary the width with a zoom-lens effect. Fixed scan-line scanners usually offer 300-dot/in. max (sometimes 400-dot/in.) resolution. To some extent, the scanner industry has standardized on 300 dots/in. because manufacturers of raster-output devices such as laser printers have standardized on 300 dots/in.

Most low-cost scanners also provide resolution levels adjustable to less than 300 dots/in. To produce the lower resolution, they typically digitize at 300 dots/in. and then convert to a lower resolution by processing the data. In fact, some scanners even attempt to increase effective resolution by processing the 300-dot/in. data.

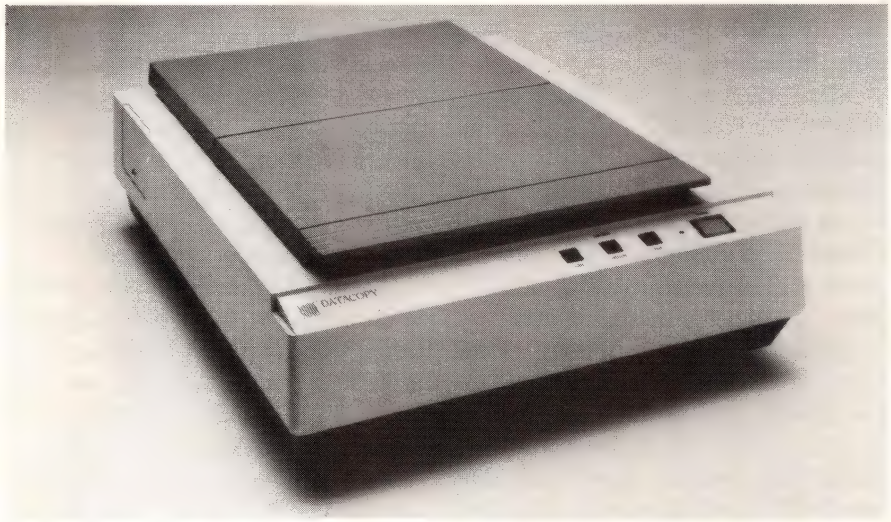
Different types of scanners represent images in vastly different ways. Some units supply their host computer with one bit/pixel, signifying black or white. Other scanners provide 2 to 8 bits/pixel to define gray scale (levels of gray between black and white). At eight bits/pixel, a scanner can represent 256 levels of gray.

Most scanners also can produce a halftone bit map. By mixing black and white pixels, halftone images emulate gray scale; the human eye integrates the halftone image as gray levels. Some scanners produce the halftone in the scanner; some require help from the host software. The best halftone images come from true gray-scale scanning that's then converted to a halftone image.

A scanner can form halftone images with a variety of patterns. For example, within a given cell or area, it might implement a gray shade with a spiral pattern, a random pattern, a checkerboard pattern, or another pattern of black and white pixels. The lower-cost scanners typically offer a couple of pattern choices, whereas more expensive scanners may offer eight or more pattern choices.

The format that scanner manufacturers use to transfer and store image data also varies. Some scanners compress data on the fly to minimize the amount of data they must transfer to the host. Others include compression capabilities on the scanner interface in the host or compression by the host software. No matter what you plan to do with your image scanning system, the software must be compatible with the storage format.

TECHNOLOGY UPDATE



A proponent of the TIFF and an advocate of the Prescript *scanner-procedure language, Datacopy plans to stress standardization in scanners such as its flat-bed Model 730.*

IBM PC-compatible interface card or a SCSI interface. With controlling software and source code, the scanner costs $4890. It can digitize a letter-size document in 6.5 sec and discern 256 levels of gray, but you can program the scanner to provide the data in 1-, 2-, 4-, or 8-bit/pixel formats. You have a choice of halftone patterns, too.

Datacopy also manufactures a 256-level gray-scale overhead scanner. Essentially, the Series 900 scanner is a camera, except it stores the image digitally rather than on film. It uses a flat image platform and, unlike the Truvel scanner, a stationary framing and focus stand.

The stand holds the CCD sensing mechanism and a 35-mm lens. Within the mechanism, a stepper motor moves the CCD array to scan multiple lines. Because the array moves within the camera mechanism, you aren't limited to using the device with its flat bed and stand. (If you do, however, four flood lamps illuminate the entire image bed.)

By moving the camera up and down over the frame and focusing stand, you can effectively zoom the lens. The company doesn't use a zoom lens itself because of problems with curvature. By decreasing resolution, you can scan C-size documents. An IBM PC-compatible 400-dot/in. unit, frame and focus stand, interface card, and software sells for $15,950. The company also offers models compatible with CAE workstations.

Datacopy offers the same WIPS software for this series that it does for its sheet-fed and flat-bed scanners. You have a choice: either 200- or 400-dot/in. resolution (8½×11-in. images).

Overhead scanning systems allow you to easily vary resolution, change document size, substitute lenses, and scan 3-dimensional items. With the Datacopy Series 900, you can even use a microscopic lens and inspect individual chips on a wafer of ICs.

You can also readily adapt the Series 900 to digitize engineering drawings. In fact, all Datacopy scanners running WIPS will produce a raster data file compatible with Autodesk's (Sausalito, CA) CAD/camera. The CAD/camera program converts raster files to a vector representation compatible with the company's AutoCAD program.

Other vendors of low-cost scanners also plan to link up with CAD/camera. About the time this article appears, Microtek should release an update to its Eyestar program to produce CAD/camera-compatible files.

In addition, Houston Instrument offers a reasonably priced E-size

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EDN033187

UPDATE

scanning device, Scan-CAD, which converts the company's DMP-50 Series plotters into scanners. It costs less than $3000; the plotters cost around $5000. Scan-CAD includes a scan head, an interface to the IBM PC, PC/XT, and PC/AT (and compatibles), and software to capture the raster image. The software that comes with Scan-CAD only captures images and stores them in CAD/camera format.

The scanning head carries its own light source and a CCD array and operates at 200 dots/in; it must digitize a drawing one 0.6-in. strip at a time. The scanner reads four bits per pixel for 16 shades of gray and takes 24 minutes to scan an E-size drawing. Your computer may lengthen the time required substantially, depending on its processing power and storage capability.

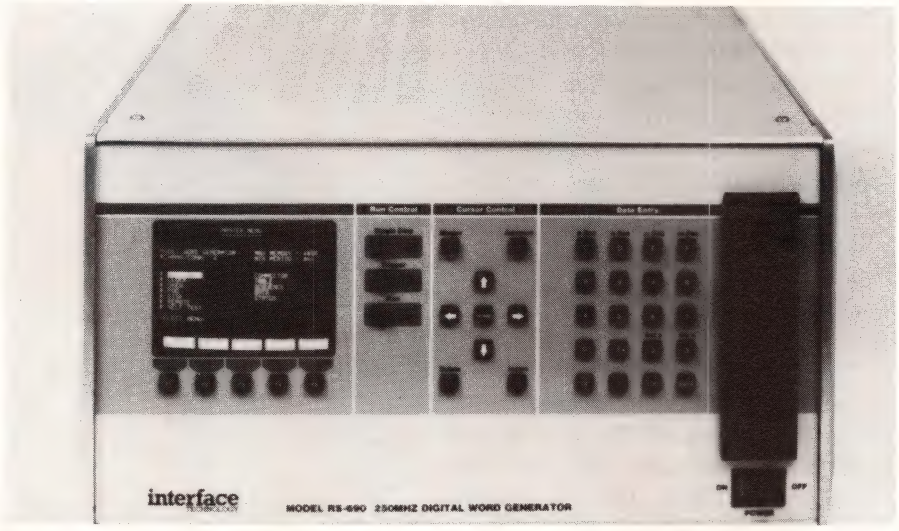
Galileo Electro-Optics has also recently introduced a scanning attachment for plotters that uses fiber optics that channel light to a linear photodiode array. The company claims its product will work with either Houston Instrument or Hewlett-Packard plotters. Galileo doesn't provide software to control a plotter's paper-transport mechanism. Prototypes sell for about $3000.

Attaching a scanning element to another peripheral provides the ultimate low-cost approach to scanning, and this fact hasn't been lost on the printer manufacturer Epson. The company recently introduced an image scanner compatible with the EX-800, EX-1000, and LQ-2500 printers. The scan head inserts into the printhead carriage in place of a ribbon cartridge. For less than $300, you get 180-dot/in. resolution and IBM PC-compatible software to control the scanning of images.

EDN

Article Interest Quotient
(Circle One)
High 500 Medium 501 Low 502

Digital word generator operates at 250-MHz data rates across 32 channels



Driving 32 channels of output at 250 MHz, *Model RS-690 digital word generator can be used as a stimulus for testing ASICs, high-speed computer chips, or telecommunication chips. You can vary the generator's outputs in both time (with 50-psec resolution) and amplitude (with 10-mV resolution).*

You can use the RS-690 digital word generator in test situations to drive device inputs at rates as high as 250 MHz across 32 channels. You can set the timing of the transition edges on the output data to within 50-psec increments. Also, you can set the output-data amplitudes with 10-mV resolution.

The word generator operates at a basic clock speed of 62.5 MHz. You can install one or two 64-channel cards in the instrument. Each channel has 1k bits of memory for output rates as high as 62.5 MHz. The generator can achieve clock rates to 125.0 MHz by interleaving every other channel's memory and time-multiplexing their outputs. Consequently, you can run 64 channels at 125 MHz with 2k bits of memory per channel. By again interleaving the memories and time-multiplexing the outputs, you can operate 64 4k-bit channels at data rates to 250 MHz.

If you need more memory, you can continue to interleave memories without increasing the data rate. For example, you can run 16 channels with 8k bits of memory per channel, or eight channels with 16k bits/channel, at 250 MHz. No other currently available pattern generators can run as many channels at 250 MHz as the RS-690 can. (The generator from Outlook Technology (Campbell, CA) will be able to run 32 channels at 250 MHz, but won't be ready until later this year.)

To program the data patterns, you divide the memory into tables (16 max). A table can be as short as one word or as long as the maximum memory length. You then assign a data rate or clock rate to each table and program the tables' sequence.

For example, assume that table 1 consists of one word clocked at 550 msec, which represents an idle state before a burst of pulses. Table 2 is programmed to provide the burst of pulses at a 250-MHz data rate. You can then loop, concatenate, and nest the tables to build your final program of patterns. The generator cycles through the tables without showing any discontinuities in the outputs when the program switches between tables.

A second way to enter patterns is to enter the time lapse between edge transitions. Edges can be set in 50-psec increments, a capability that represents twice the resolution of Hewlett-Packard's 8180B word generator, Integrated Measurement Systems' (Beaverton, OR) Logic Master 2000, or Tektronix's Delta Series testers. (Outlook Technology's unit will not have the edge-placement-setting capability.)

The ECL outputs at the back of the RS-690 are fed to 16-channel fixed ECL-level output pods, 16-channel fixed TTL-level output pods, or 4-channel variable-amplitude pods.

You can program the variable-amplitude pod outputs to provide a pulse of as much as 5V p-p anywhere in a ±5V range. The pod's amplitude resolution is 10 mV. No other generator provides variable voltage outputs at 250 MHz.

All the generator's programming can be accomplished through the front-panel keyboard, which offers soft keys and menus, or via the IEEE-488 or RS-232C ports. The RS-690 also has a built-in, 5½-in. IBM PC-formatted floppy-disk drive for storing test setups and data patterns. With one 64-channel card installed, the RS-690 mainframe costs $27,000. The output pods range in price from $1500 to $5000 each. Delivery, eight weeks ARO.—***Chris Everett***

Interface Technology, 2100 E Alosta Ave, Glendora, CA 91740. Phone (818) 914-2741. TLX 4945489.

Circle No 726

PRODUCT UPDATE

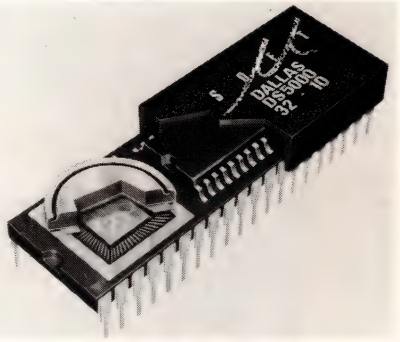
8-bit microcontroller offers crashproof operation

You can now obtain an 8-bit microcontroller that offers software security, crashproof operation, and remote software manipulation in a single 40-pin DIP. The DS5000 Soft Microcontroller features an 8-bit CPU, on-chip encryption logic, 8k or 32k bytes of nonvolatile high-speed static RAM, a serial I/O port, 32 parallel I/O lines, and two 16-bit event counter/timers.

Operating at 8-, 10-, and 12-MHz clock rates, the CMOS device is pin compatible with Intel's 8051 microcontroller and uses the same instruction set. Thus, you can develop new designs for the DS5000 by using development tools and software packages that are currently available for the 8051 architecture.

To prevent system crashes caused by low operating voltage, the DS5000 automatically halts processor operation when it detects low input voltage. The chip's lithium energy source backs up all device data, including internal registers, configuration data, and key variables. Upon restoration of the input voltage, the microcontroller automatically boots and resumes its application-software processing. An on-chip watchdog timer monitors software execution and automatically resets the processor in the event of a software malfunction.

An on-chip data loader lets you modify the DS5000's program, data, variables, and configuration parameters via the device's serial port or its parallel EPROM programmer. You can dynamically partition the chip's RAM to fit the program- and data-storage requirements of a particular task. The device even accepts changes in the ratio of program memory to data memory during program execution.



Combining an 8-bit CPU with 8k or 32k bytes of nonvolatile static RAM, *the DS5000 Soft Microcontroller provides crashproof operation and remote programmability.*

You can change any program, data, or variable information at any time without physically removing the microcontroller from your system. Further, you can perform remote modifications via modem, thus avoiding on-site customer-service calls. You can also develop software that will enable the DS5000 to modify its data and program memory.

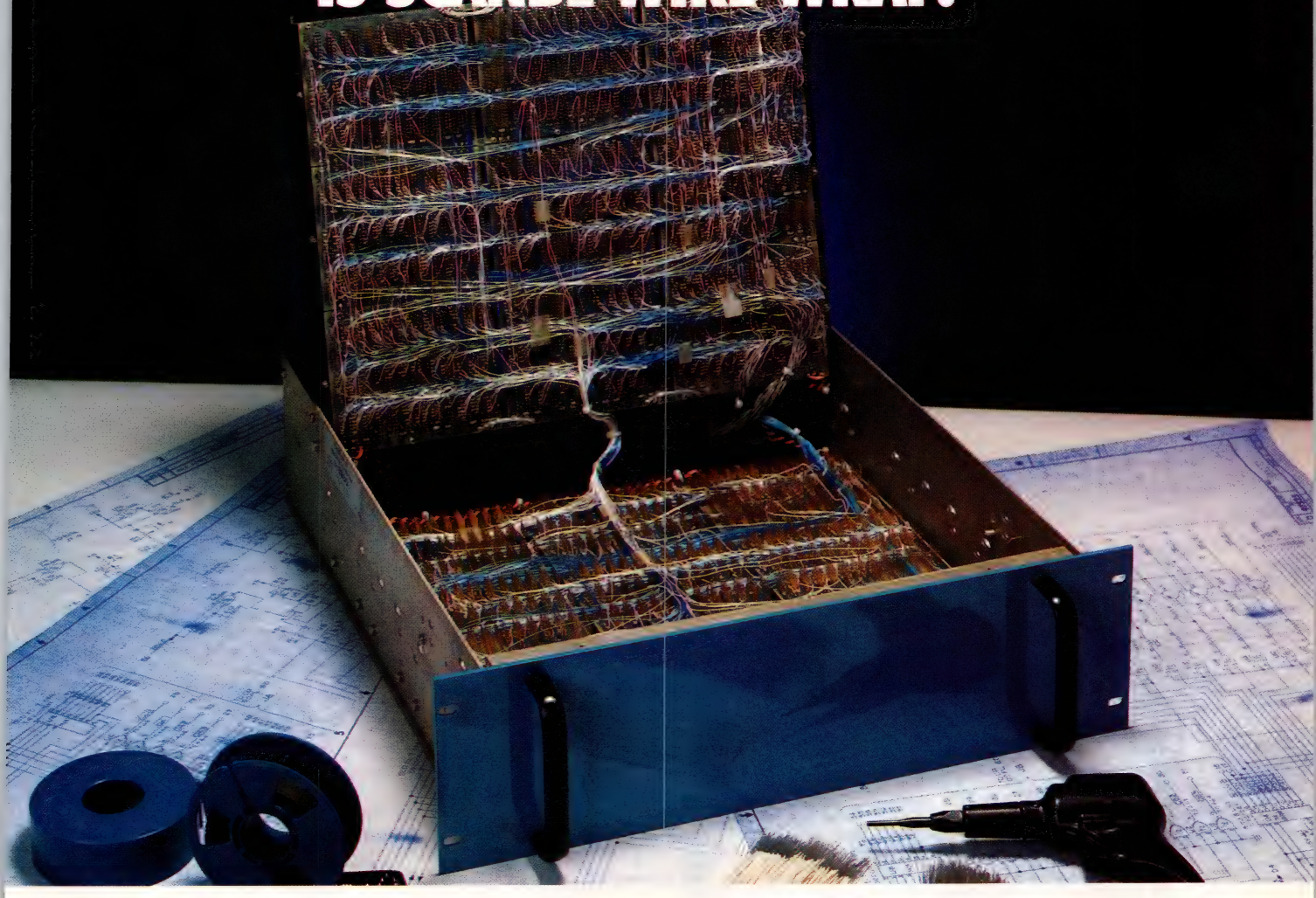
The microcontroller provides software security by encrypting data according to an internal 40-bit key word. You can load and execute application software in encrypted form to prevent unauthorized access. If someone attempts to read the key word by resetting the security-lock bit, the chip automatically erases the key word, making the RAM contents indecipherable and preventing the program from running.

The DS5000 operates in temperatures ranging from 0 to 70°C. Its lithium power source provides more than 10 years of data protection. The 32k-byte version costs $78 (100). With 8k bytes of RAM, it sells for $59 (100).—***J D Mosley***

Dallas Semiconductor Inc, 4350 Beltwood Parkway, Dallas, TX 75244. Phone (214) 450-0400.

Circle No 727

THE SHORTEST TIME FROM CIRCUIT DESIGN TO FINISHED PRODUCT IS SCANBE WIRE WRAP.



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CIRCLE NO 185

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241	541	620	862	534	824	533	844
244	827	623	863	564	825	563	845
465	828	640	864	574	826	573	846
466		643		575	874	580	880
467		645		576	876	841	
468				577	878	842	
				821	879		
				822			

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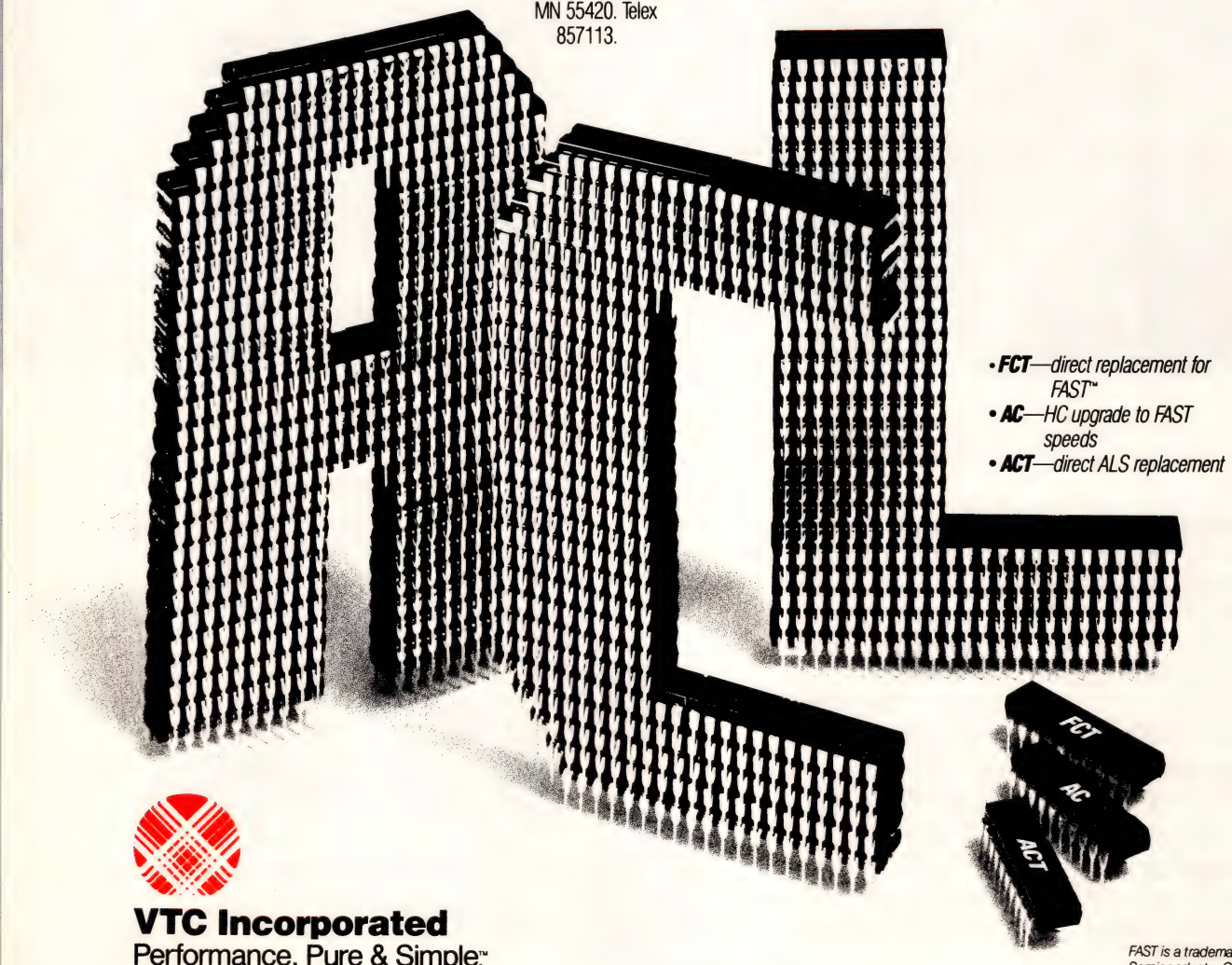

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CIRCLE NO 194

14,400-bps facsimile modem fits on 65×100-mm board

The HF144 fascimile modem is 50% faster than previous fax modems, yet it fits within the same 65×100-mm form factor; it consumes 1W. Earlier fax modems ran at 9600 bps; the HF144 achieves a top speed of 14,400 bps.

Both the board's form factor and its 40-pin connector comply with the de facto standard established by Rockwell International (Newport Beach, CA) for modem boards incorporated in high-speed facsimile machines. The HF144 can operate at 14,400, 12,000, 9600, 7200, 4800, 2400, and 300 bps. It can receive and transmit over dedicated unconditioned lines or over the general switched telephone network, and it can operate in both Group 2 and Group 3 fax machines.

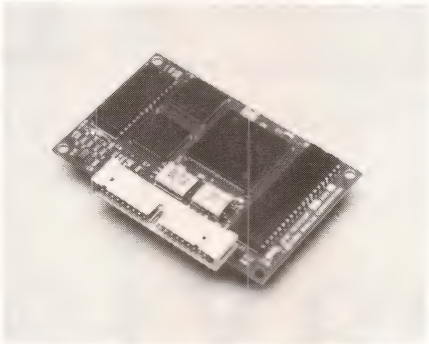
In the V.33 configuration, which specifies transmission at 14,400 and 12,000 bps, the modem uses 8-state trellis-coded modulation. Trellis-coded modulation results in improved signal quality; the term "trellis" refers to the shape the output signal takes in an eye-pattern display.

When operating the modem at 9600 bps, you can choose between the V.29 and TC96 modes. The TC96 mode implements the data encoding as specified in the V.32 standard; V.29, the CCITT standard for 9600-bps operation, does not specify trellis coding. When operating the modem at 14,400, 12,000, or 9600 bps, you can choose either an 1800- or a 1700-Hz carrier frequency. The V.33 standard specifies 1800 Hz; however, if your fax machine will need to operate over noisy lines, you might want to choose 1700 Hz to avoid signal attenuation.

A fax machine's host microprocessor controls the HF144's modes and configurations through the modem's two 16-register banks that are addressed as part of the host's memory. The registers also contain status and software flags. For example, you can monitor transmitted and received data quality with the Eye Quality Monitor (EQM) register. To obtain a display of the eye-quality pattern, you can use three analog signals supplied by the modem's hardware interface: XYEYE, $\overline{\text{EYECLK}}$, and LOAD. The all-CMOS unit operates from +5 and ±12V and costs $355. It will be available in production quantities in mid-June.—***Margery S Conner***

Emulex Corp, Box 6725, Costa Mesa, CA 92626. Phone (800) 368-5393; in CA, (714) 662-5600. TWX 910-595-2521.

Circle No 729



Measuring 65×100 mm and consuming only 1W typ, *the HF144 fax modem can transmit and receive trellis-coded data at a top speed of 14,400 bps.*

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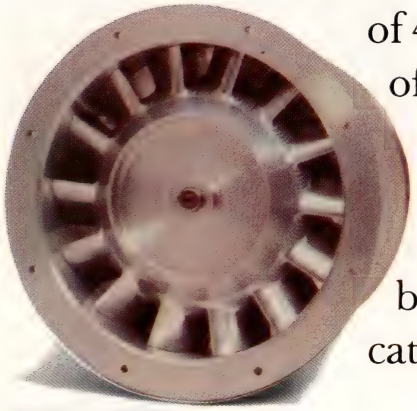

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CIRCLE NO 145

See us at Electro Booth 1672

Parallel/serial FIFO memory eases buffer design

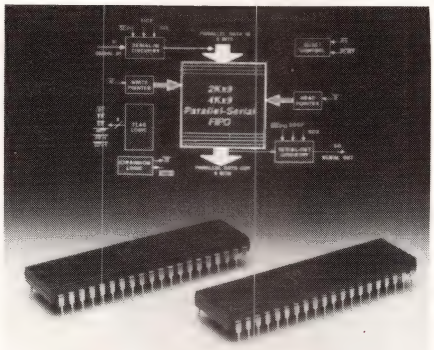
To create its IDT72103 and IDT72104 CMOS parallel/serial FIFO memories, the vendor has placed much of the necessary support circuitry—including shift registers and control logic—on chip. You can use both devices in parallel-to-parallel, parallel-to-serial, serial-to-parallel, or serial-to-serial configurations.

The FIFO memories are configured as 2048 words×9 bits and 4096 words×9 bits, respectively. The ICs' serial input and output circuitry includes what the manufacturer refers to as the Flexishift feature, which allows you to program the serial word length from four bits to any number of bits without adding external logic.

You can expand the word beyond nine bits by using more than one FIFO memory. The FIFO memories include on-chip control signals and logic that allow you to expand word width, depth, or both without adding external circuitry.

The standard flags available in a FIFO memory are the Empty and Full flags; many FIFO memories also include Half Full flags. The IDT72103 and IDT72104 have these as well as a few extra flags: the Full−1, Empty+1, and Almost Empty/Full flags. The Full−1 and Empty+1 flags indicate that the FIFO buffer has only one vacant or one filled location, respectively. Depending on the status of the Half Full flag, the Almost Empty/Full flag indicates that the FIFO buffer is either less than ⅛ full or more than ⅞ full.

Both devices have a parallel-port access time of 50 nsec and allow a serial I/O frequency of as much as 40 MHz. Access to the RAM array is asynchronous, so the chips can perform simultaneous read and write operations.



By including shift registers and control logic on chip, *the IDT72103 and IDT72104 FIFO memories make it easy for you to move large amounts of data between systems.*

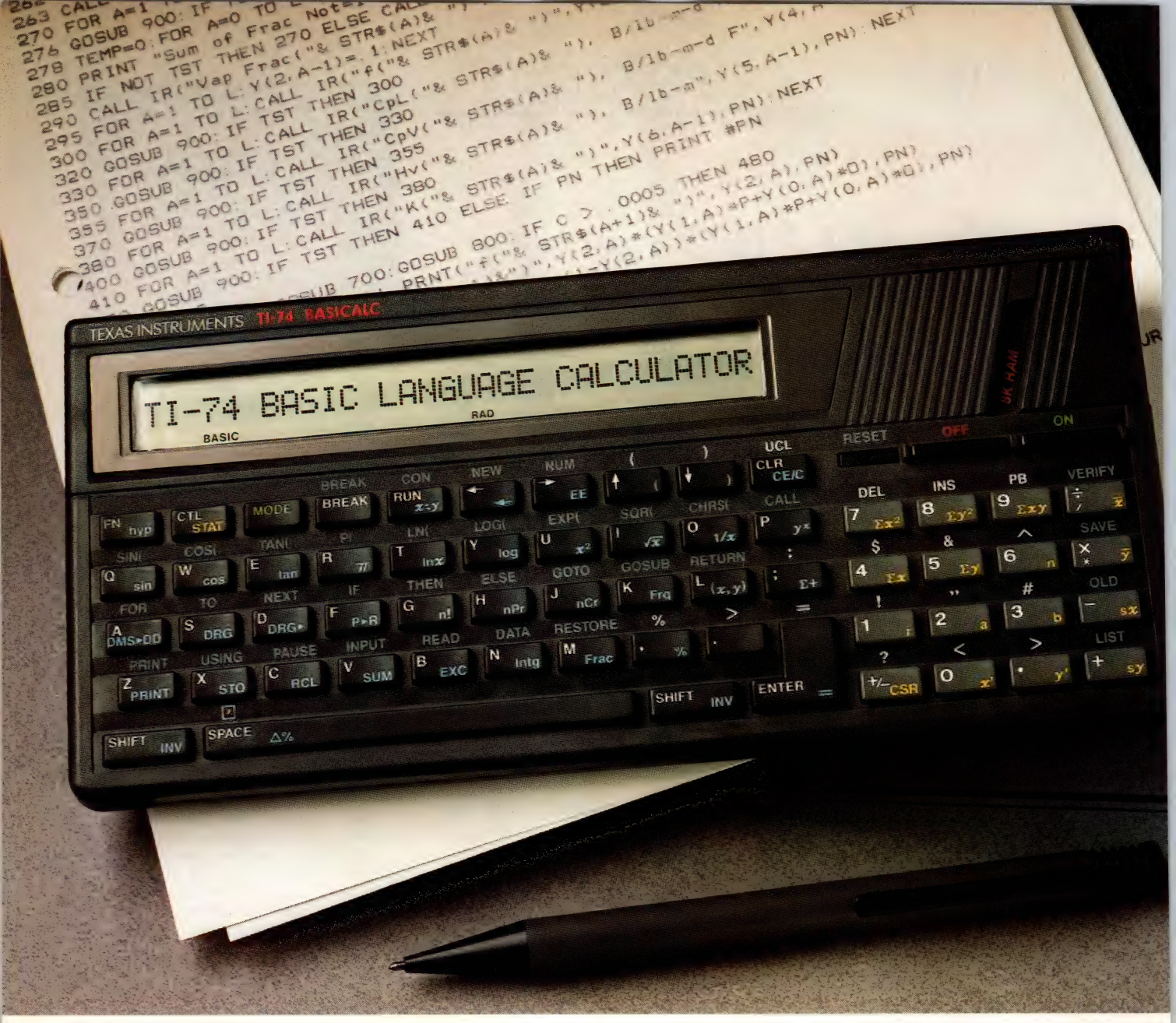
In the single-device mode, the FIFO memories have a retransmission capability, which is useful in applications (such as digital signal processing) that require multiple but repeating values. To use an IDT72103 or IDT72104 in such an application, you can load the FIFO memory with the coefficient table and then retransmit the coefficients when the DSP algorithm needs them.

Fabricated in the company's CMOS process, the devices are available in 40-pin ceramic or plastic DIPs; 44-pin LCCs; and 44-pin, J-lead plastic leaded chip carriers (PLCCs).

The IDT72103 and IDT72104 will be available in April. An IDT72103 in a commercial-grade plastic DIP costs $37; in the same package, the IDT72104 sells for $55 (100). Versions screened to MIL-STD-883 are available.—***David Shear***

Integrated Device Technology Inc, 3236 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-6116. TWX 910-338-2070.

Circle No 728



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TEXAS INSTRUMENTS

CIRCLE NO 189

Injection-molded parts reduce cost of pen plotter

The Draftsmaster pen plotter features a drawing speed of 24 ips, which represents a 50% increase in throughput over that of the company's previous plotters (the 758X Series). The new plotter is also more reliable and costs less than the previous version.

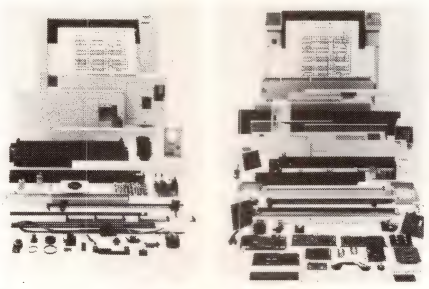
The manufacturer has improved the reliability of its plotter by building the product with one-third as many parts as the previous model. To prove its confidence in the new plotter's reliability, the company is charging $240 for an annual service contract. In contrast, the annual service contract for the 7585 costs $720.

The design changes that improve the plotter's reliability include the addition of injection-molded parts. Each of the injection-molded thermoplastic parts replaces several parts in the older systems; further, the injection-molded parts don't require adjustment. The 758X plotters required 26 service adjustments; the Draftsmaster plotters need only two.

A 10-MHz 68000 μP enables the plotter to optimize its pen motions. For example, the microprocessor sorts instructions by color, so the plotter needs to pick each pen only once during a plot.

To further increase its plotting speed, the plotter ignores unnecessary pen-up moves. Instead of lifting a pen and putting it down during each move, the plotter consolidates all pen-up commands and moves each pen directly to the place where its next line begins.

Bidirectional plotting permits the plotter to start a line at either endpoint. The plotter begins each line at the endpoint that is closest to the current pen position.



By using injection molding and custom ICs, *Hewlett-Packard builds its Draftmaster I 8-pen plotter* ***(left)*** *with one-third as many parts as the company's earlier 7585B* ***(right),*** *which the new plotter replaces.*

Further, the pen plotter doesn't just draw straight lines—it also draws curves. Its smooth-curve generator produces continuous curves by looking ahead and identifying curves. When the curve generator detects a small angle change in the next vector of a line, it assumes that the line is a curve. The plotter doesn't lift its pen or decelerate. Because its speed remains constant, it draws curves that look smooth.

To prevent paper or other plotting media from bouncing, the plotter includes a polyimide stabilizer. The stabilizer flexes with the plotting medium, thereby dampening vibrations.

The Draftsmaster can create engineering drawings in sizes A to E, and it can place a point on a drawing to within 0.001 in. The plotter is available in two models. Draftsmaster I, which costs $9900, plots drawings on single sheets of paper. The $11,900 Draftsmaster II is a roll-feed plotter.

—Eva Freeman

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 725

READERS' CHOICE

Of all the new products covered in EDN's **January 22, 1987,** issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **January 22, 1987,** issue.

▲ CALCULATOR

The HP-28C is the first electronic calculator that's capable of performing symbolic mathematics, according to the manufacturer (pg 92).
Hewlett-Packard Co.
Circle No 601

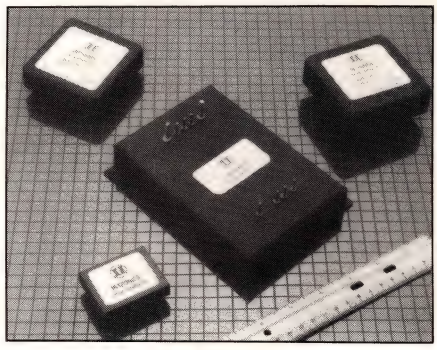
Iskrascope LCD folds conveniently into its own carrying case.

▲ LCD SCOPE/METER

The Iskrascope LCD combines the function of a digital oscilloscope, a signal averager, and a digital multimeter (pg 282).
Iskra.
Circle No 604

PC/AT CHIP SET

Poach (PC on a chip) is a 2-chip set that replaces more than half the devices found on a PC/AT's mother board (pg 257).
Zymos Corp.
Circle No 602



▲ CONVERTERS

PC-board-mountable and available as single- or triple-output modules, the KZ-100, -200, -300, and -400 are rated at 15, 25, 40, and 100W, respectively (pg 270).
Intronics.
Circle No 603

MATH LIBRARY

Mathpac is a library of more than 400 routines that are written in ANSI 77 Fortran and assembly language. The library is optimized for use with the 8087 and 80287 math coprocessors in IBM PCs and compatibles (pg 283).
Systolic Systems Inc.
Circle No 605

(TEDDY TELLS ALL)

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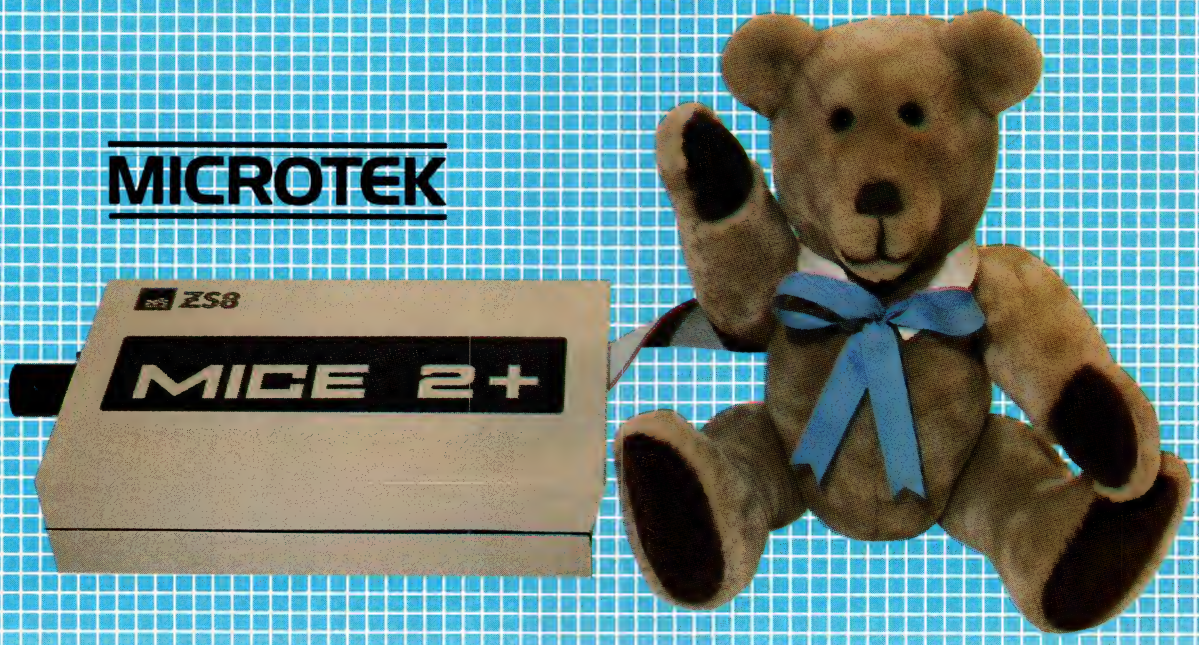

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CIRCLE NO 168

LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
TRANSFORMERS								
Toroidal	0	9	45	46	0	0	11.0	8.8
Pot-Core	0	13	50	37	0	0	10.2	10.5
Laminate (power)	7	13	47	33	0	0	9.3	8.0
CONNECTORS								
Military panel	0	25	25	25	12	13	13.7	8.8
Flat/Cable	21	47	16	16	0	0	5.1	5.9
Multipin circular	0	27	33	13	13	14	13.1	9.6
PC	0	64	18	18	0	0	6.2	5.7
RF/Coaxial	21	29	36	7	7	0	6.6	5.4
Socket	20	40	27	13	0	0	5.4	4.4
Terminal blocks	12	41	35	12	0	0	5.9	5.6
Edge card	13	33	40	14	0	0	6.3	7.0
Subminiature	20	30	40	10	0	0	5.7	6.4
Rack & panel	0	29	57	14	0	0	7.6	6.2
Power	15	31	39	8	0	7	7.6	7.4
PRINTED CIRCUIT BOARDS								
Single-sided	0	55	40	5	0	0	5.6	4.8
Double-sided	0	38	58	4	0	0	6.4	6.5
Multilayer	0	23	62	15	0	0	8.0	8.9
Prototype	0	79	11	10	0	0	4.8	4.4
RESISTORS								
Carbon film	50	29	21	0	0	0	2.5	4.2
Carbon composition	43	29	10	19	0	0	4.9	3.9
Metal film	44	16	36	4	0	0	4.0	4.5
Metal oxide	30	39	31	0	0	0	3.6	4.3
Wirewound	16	28	56	0	0	0	5.3	2.4
Potentiometers	17	33	38	12	0	0	5.9	5.9
Networks	7	47	33	13	0	0	6.1	6.1
FUSES	29	29	35	7	0	0	4.8	2.4
SWITCHES								
Pushbutton	6	19	63	12	0	0	7.5	4.7
Rotary	5	18	65	12	0	0	7.5	5.7
Rocker	20	13	47	20	0	0	7.2	4.6
Thumbwheel	0	22	45	22	11	0	10.5	5.4
Snap action	20	20	30	20	10	0	8.7	3.5
Momentary	10	20	50	10	10	0	8.7	4.4
Dual in-line	17	33	17	17	16	0	9.2	4.2
WIRE AND CABLE								
Coaxial	43	28	29	0	0	0	3.1	1.8
Flat ribbon	47	20	33	0	0	0	3.3	1.7
Multiconductor	42	17	42	0	0	0	3.8	2.9
Hookup	61	30	9	0	0	0	1.6	1.5
Wire wrap	58	25	17	0	0	0	2.1	1.0
Power cords	36	23	36	5	0	0	4.3	4.3
Other	33	33	17	17	0	0	4.9	5.8
POWER SUPPLIES								
Switching	0	18	46	36	0	0	9.8	6.5
Linear	20	20	50	10	0	0	6.2	4.8
CIRCUIT BREAKERS	20	20	33	27	0	0	7.4	5.7
HEAT SINKS	27	20	47	6	0	0	5.4	3.9

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
RELAYS								
General purpose	28	22	39	11	0	0	5.5	5.2
PC board	0	25	58	17	0	0	8.0	8.1
Dry reed	25	25	37	13	0	0	5.7	6.9
Mercury	0	22	67	11	0	0	7.7	7.6
Solid state	21	36	29	14	0	0	5.6	8.9
DISCRETE SEMICONDUCTORS								
Diode	38	23	31	8	0	0	4.3	4.8
Zener	25	25	30	20	0	0	6.3	5.7
Thyristor	23	39	23	15	0	0	5.4	6.5
Small signal transistor	19	31	31	13	6	0	7.0	5.3
FET, MOS	24	23	18	35	0	0	7.6	7.6
Power, bipolar	25	8	33	34	0	0	8.1	4.8
INTEGRATED CIRCUITS, DIGITAL								
CMOS	10	26	32	32	0	0	8.2	6.4
TTL	31	19	38	12	0	0	5.5	6.5
LS	8	42	42	8	0	0	5.9	5.7
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	0	14	57	29	0	0	9.4	6.3
OP amplifier	10	20	40	30	0	0	8.5	6.5
Voltage regulator	11	33	39	17	0	0	6.7	6.6
MEMORY CIRCUITS								
RAM 16	37	18	27	18	0	0	5.5	4.0
RAM 64	20	40	30	10	0	0	5.2	4.2
RAM 256	20	20	40	20	0	0	6.9	5.0
ROM/PROM	22	22	45	11	0	0	5.9	5.3
EPROM	14	29	36	21	0	0	7.0	6.9
EEPROM	22	11	45	22	0	0	7.3	8.2
DISPLAYS								
Panel meters	11	45	33	11	0	0	5.7	6.4
Fluorescent	20	20	20	40	0	0	8.4	10.1
Incandescent	0	50	25	25	0	0	7.4	4.3
LED	17	33	33	17	0	0	6.3	5.6
Liquid crystal	0	31	46	23	0	0	8.2	7.2
MICROPROCESSOR ICs								
8-bit	27	9	37	27	0	0	7.4	4.2
16-bit	20	10	50	20	0	0	7.4	2.9
FUNCTION PACKAGES								
Amplifier	25	0	50	12	13	0	9.1	4.9
Converter, analog to digital	0	30	50	20	0	0	8.0	8.6
Converter, digital to analog	0	22	56	22	0	0	8.6	8.5
LINE FILTERS	11	33	34	22	0	0	7.1	6.4
CAPACITORS								
Ceramic	13	39	35	9	4	0	6.4	5.2
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Ceramic disc	14	33	29	19	5	0	7.5	5.5
Film	10	30	35	20	5	0	8.1	5.9
Electrolytic	21	25	33	21	0	0	6.6	6.6
Tantalum	13	22	52	13	0	0	6.8	6.6
INDUCTORS	0	18	64	18	0	0	8.5	5.5

Source: *Electronics Purchasing* magazine's survey of buyers

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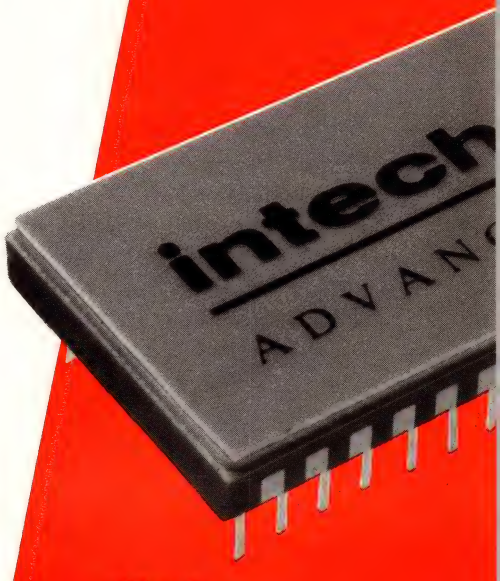

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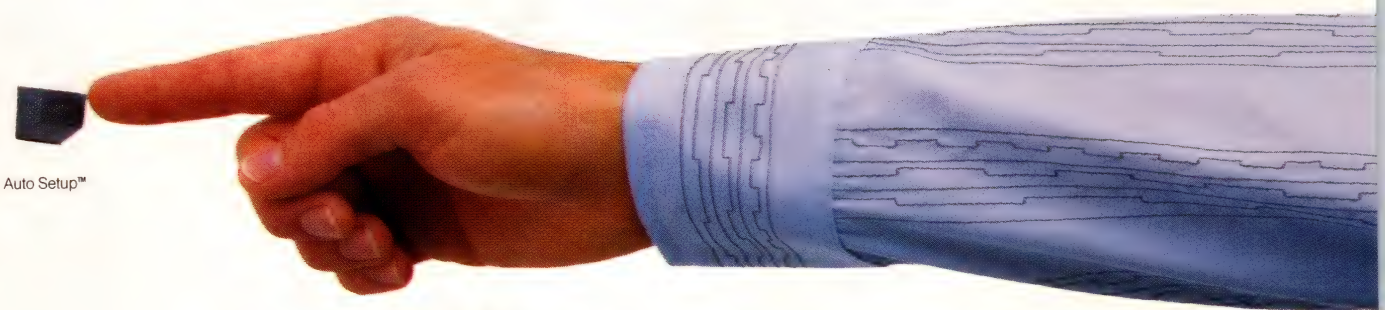

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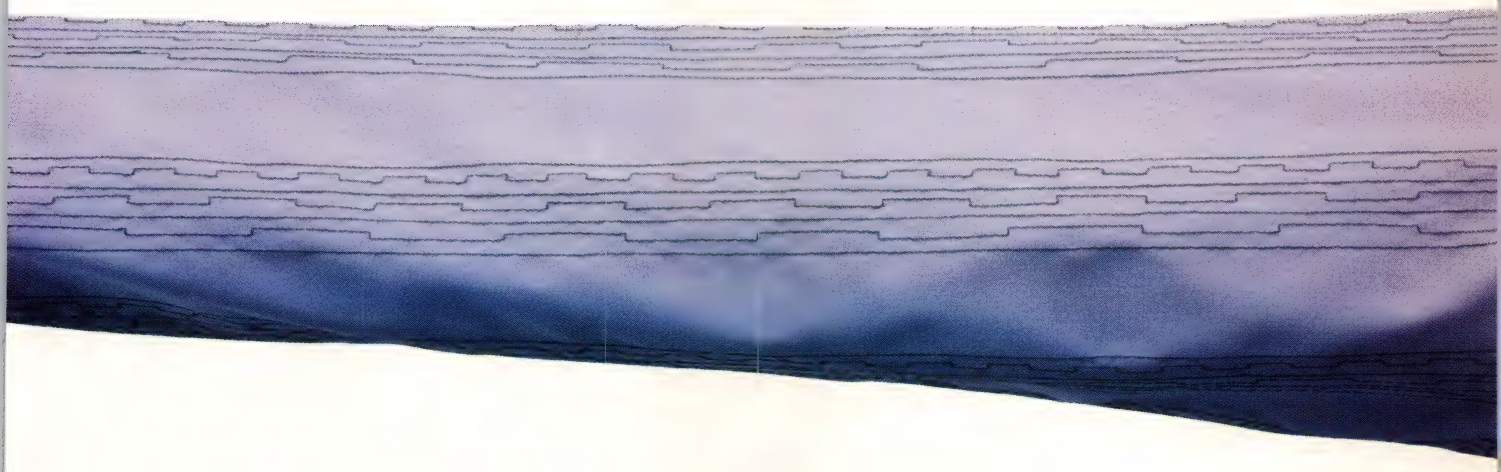

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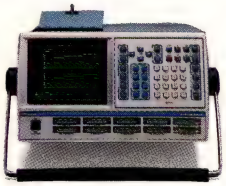

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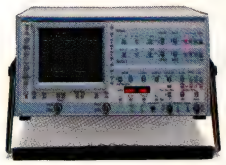

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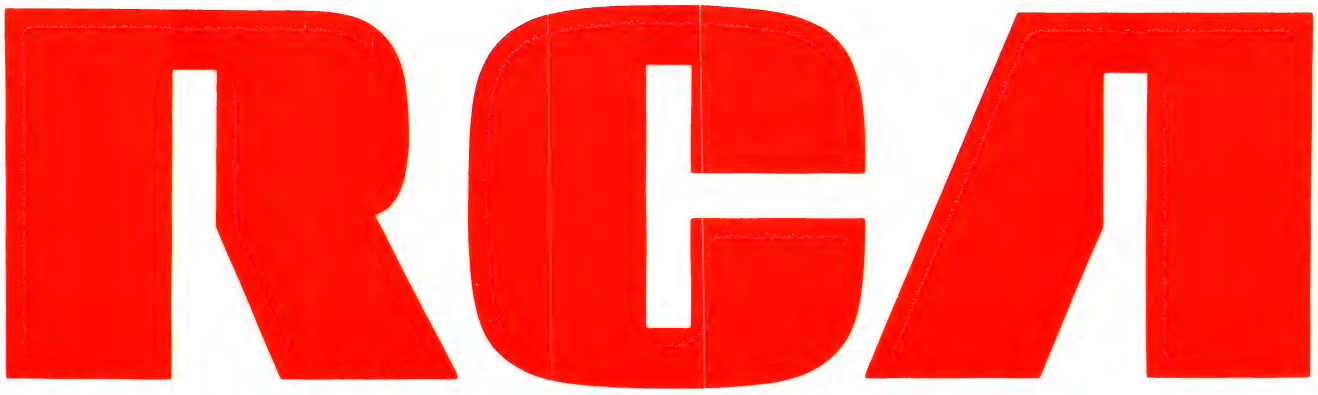

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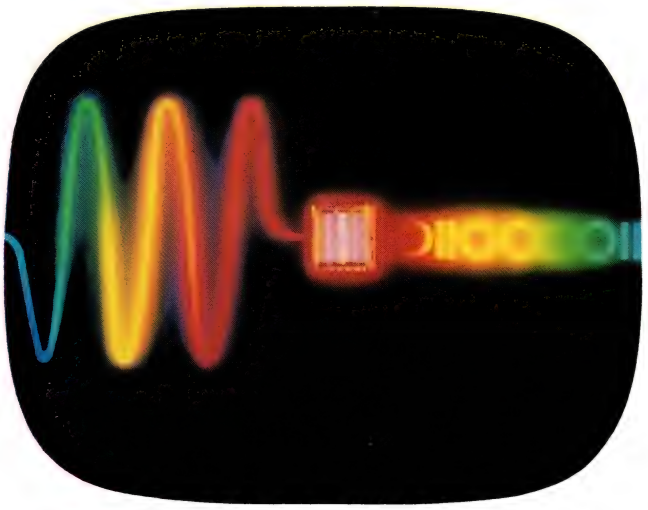

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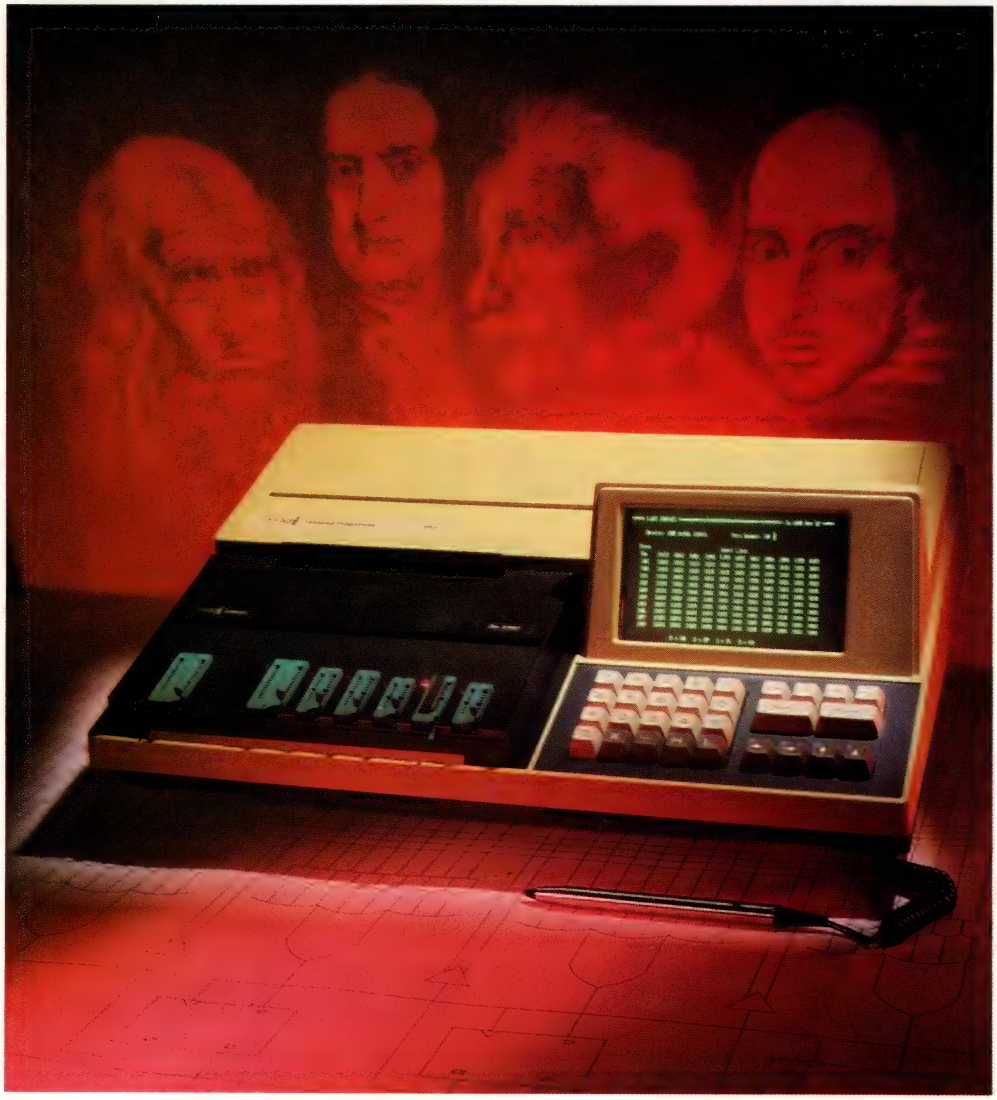
Special Report

PLD programmers

Charles H Small,
Associate Editor

Although design engineers will increasingly use device programmers in the course of their development work as programmable-logic devices (PLDs) find more applications, they probably give their programmers no more consideration than they do any other useful, but mundane, tool such as a pencil sharpener or an X/Y plotter. Consequently, engineers could be ignoring important distinctions between different device programmers. Furthermore, PLD-programmer makers say that too many ill-informed engineers fail to take advantage of important capabilities of their programmers, such as the ability to test PLDs and do development.

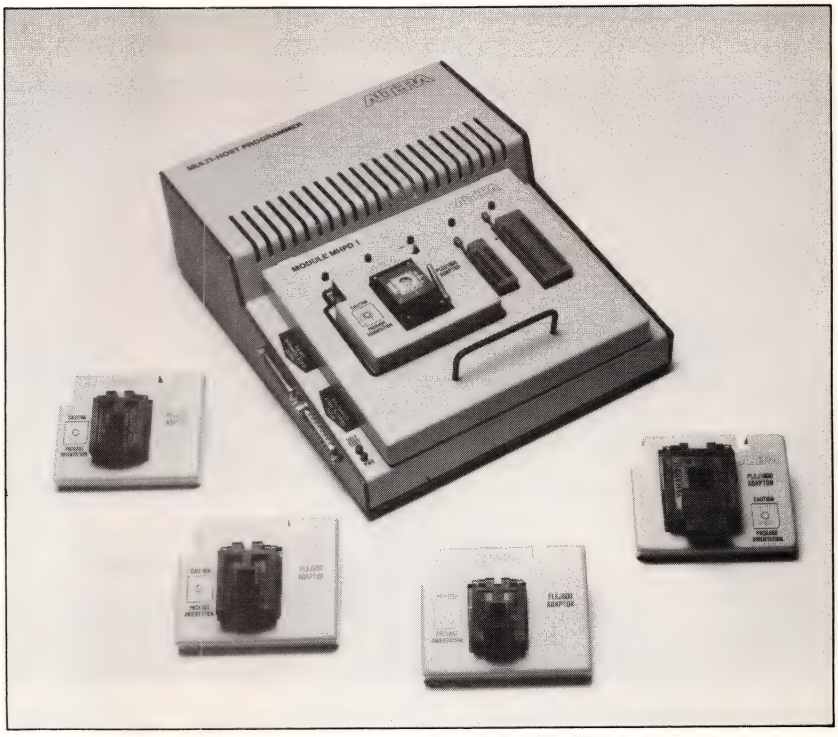


You can make your best ideas a reality *when you complete the design of your PLDs using today's PLD programmers. (Photo courtesy Stag Microsystems)*

Exhibiting a surprisingly large range of features, architectures, and even some unsuspected abilities, PLD programmers stand ready to aid design engineers as they move from TTL devices to PLDs.

Part of the reason for the lack of consideration of PLD programmers is their close relationship to more-familiar PROM programmers. Because PLDs are following much the same development path as PROMs, PLD programmers are also recapitulating the development history of PROM programmers (with some notable differences).

For example, bipolar PROMs program quickly, and industry therefore generally uses single-device programmers (and perhaps a handler) even in high-volume production environments. But with the appearance of erasable PROMs (EPROMs and EEPROMs) and their much longer programming times, industry has turned to gang programmers, available from a host of manufacturers, to achieve acceptable production volumes.



Not all makers of large PLDs with exotic architectures *wait for the PLD-programmer industry to gear up for their PLDs; Altera makes its own PLD programmer.*

Only two gang PLD programmers

The development of PLD programmers is a step or two behind. Although erasable PLDs and other, large PLDs—both of which can take several minutes to program—have been on the market for three years now, to date only Stag and Varix offer gang PLD programmers (Model ZL33 and the Omni-Programmer, respectively). Other programmer makers are waiting for a larger market to develop before they'll deploy gang PLD programmers. In the meantime, however, Altera and Cypress aren't waiting for PLD-programmer makers to support their PLDs; the companies offer PLD programmers for their own PLDs.

In another parallel development, military-system designers are demanding PLD programmers that can program PLDs in circuit for exactly the same military-program requirements that led to the development of in-circuit PROM programmers. Sunrise and Data I/O are the leading suppliers of in-circuit programmers of both types.

PLD programmers also lag behind PROM programmers in the area of accommodating devices housed in chip carriers. Data I/O's 29B and Unisite 40 and Digilec's Model 860 have dedicated assemblies for chip carriers. Right now, most companies make do with a socket adapter that plugs into the DIP socket on their programmers. The socket adapters offered by most PLD-programmer makers differ little, if at all, because these companies are supplying a socket adapter made by the same company.

Socket adapters, pro and con

The socket adapter differs from a socket assembly in that the socket assembly interfaces directly with the programmers' electronics and mounts onto the programmer in a mechanically solid manner. Some engineers feel that socket adapters have electrical and mechanical deficiencies that relegate them to the role of a stopgap. Some production engineers, however, like the idea of having a cheap, disposable fixture.

Conceptually, the PROM programmer is a very simple instrument; you send it a list of addresses and data, and the programmer burns the data into the PROM

Despite their similarities, PROM and PLD programmers are not exactly alike.

Catering to the needs of the design engineer, *Valley Data Sciences' PC-driven PLD programmer complements the company's PLD-design software.*

at the appropriate addresses. Superficially, a PLD programmer seems just as simple. You send the PLD programmer a fuse map that describes how you want to configure the PLD's logic array, and the PLD programmer burns that map into the PLD. But significant differences exist between PROM programmers and PLD programmers.

The differences derive not so much from the programmers' hardware but rather from the devices they program (although the programmers' hardware is sufficiently similar that so-called "universal" programmers can handle both types of devices). The PROM is a simple, regular device, and all PROMs are pretty much alike no matter what size they are and which manufacturer makes them. As each new generation of PROMs emerges, each upgrade is usually a simple extension of past devices. Also, testing a PROM is easy; checking the PROM's fuses is equivalent to making a dc functional test.

Some PLD-programmer makers accommodate surface-mount devices *with a socket adapter that plugs into the DIP socket. The Digilec Model 860 accepts a chip-carrier socket assembly to replace the DIP socket assembly shown here.*

Not so for PLDs. Programming voltages for PLDs range from 5 to 27V. Programming-current requirements range from nearly arc-welding levels down to tiny fractions of an ampere. Timing schemes and pulse-quality specs are complex and diverse. Even the smallest PLDs have a complex internal architecture, of which the fuse map is only a part.

The architectures of PLDs made by different companies vary widely. And with virtually each new introduction, PLD makers spawn yet another, radically different architecture. Last, testing a PLD is not trivial; simply checking the fuse map of a PLD does *not* constitute a dc functional test of the device. PLDs have far more circuitry than just their fuse maps—with some internal features not directly accessible via the device's pins. Consequently, even a rudimentary functional test involves applying a series of test vectors to a programmed PLD and verifying its response to the vectors —a more complex task, especially for sequential PLDs,

Some PLD programmers handle many types of parts; *others are dedicated to just a few. Bytek has frozen the device coverage of its S5-A; the unit handles common 20- and 24-pin PLDs and will not be updated to handle newer devices; the company's more advanced model 125-AD will.*

than checking a PROM.

The very nature of PLDs strains the engineering capabilities of PLD-programmer makers, as they try to keep up with PLD makers and fulfill the two most basic specs for a PLD programmer: device coverage and device testing. Broad coverage can prove an elusive goal. The history of PLD programmers is littered with the remains of companies that were seduced into the field by the deceptively simple electronics needed for a PLD programmer. These failed companies found that the revenue generated from a low-cost PLD programmer wouldn't pay for the continuing battle to support the ever-growing list of PLDs.

Even a mere speed upgrade of an existing part can require the manufacturer to reprogram its programmer. Take, for example, Texas Instruments' A and B versions of its 20-pin PALs. The faster B parts use a programming algorithm that's different from that used by the A versions. The PLD programmer industry is presently in the process of updating; some PLD-programmer makers can handle the B devices, and some cannot. Those that cannot are working hard to revise their machines.

Obtaining definite specifications and samples of newly announced PLDs for engineering development is only half the battle. As is the custom in the industry, a PLD-programmer maker must get the device manufacturer to certify that the former's programmers execute the latter's programming algorithm properly.

Naturally, the device manufacturers tend to allocate their scarce engineering resources judiciously by certifying the most popular programmers first. People in the PLD-programmer industry tell horror stories about sample programmers, supplied by small PLD-programmer makers, that languished untouched in their original, unopened shipping containers under a bench in a device manufacturer's laboratory for eight months while awaiting certification.

Some PLD programmers are not completely stand-alone units. *The Varix GP1140 Omni-Programmer relies entirely on an IBM PC for memory, control, and timing.*

Even the smallest PLDs have a complex internal architecture, of which the fuse map is only a part.

The two leading companies supplying in-circuit PLD programmers *are Data I/O and Sunrise. This Data I/O Model 60 has a custom interface to a board full of PLDs.*

Although the larger PLD-programmer makers can boast of the close cooperation they enjoy with device manufacturers, the smaller manufacturers admit that they must persevere and hound the device makers to get their programmers certified. Some device makers, such as Intel, are attempting to shift back some of the burden of certification by requiring the PLD-programmer makers to fill out an extensive precertification form. That way, Intel can certify more programmers in a shorter time.

Tables 1 and **2** show an order-of-magnitude difference in price between the most and least expensive PLD programmers. The most expensive are general-purpose, universal programmers, while some of the least expensive program a subset of available PLDs or are dedicated to just a single class of PLDs. An example of the limited class includes the $995 Gtek Model 7344, which programs only common 20- and 24-pin devices; it won't handle PLDs with buried state registers. Also, Programmable Logic Technologies' $479 Logic Lab and Qwerty's $995 GPR-1000 handle only GALs (generic array logic devices) from Lattice Logic. Another company, Bytek, has frozen the specifications of its $995 S5-AD; it will only handle common 20- and 24-pin PLDs. Bytek has chosen to update its $1395 125-AD as new devices appear.

International Microsystems' ECL-1 and ECL-2 program only ECL PLDs. The company boldly claims, despite counterclaims from numerous other PLD-programmer makers, that its programmer is the only programmer that can program ECLs properly.

Take note that **Table 2** is not a complete, up-to-date list of device coverage. It gives only a general overview. Each PLD-programmer maker has a detailed device-coverage list that's far too large to reproduce here. Remember also that not every PLD programmer can handle every device in a given series and that PLD makers have been known to change abruptly the programming specs of an established part. Such parts can drop from the device-coverage lists temporarily. Consequently, the individual manufacturer's device-coverage lists change daily. To be absolutely sure that a programmer will handle a device you have in mind, you must check directly with the programmer's manufacturer.

PLD makers have represented all the devices listed in the table as being available at least as samples. In general, however, long-established devices enjoy widespread support, while new, large, exotic devices do not. Some PLD-programmer makers report difficulty in obtaining some of the devices listed in the table.

Another reason why design engineers may casually regard PLD programmers is that they may feel that a PLD programmer is a piece of production equipment. Indeed, PLD programmers' application areas span both the design lab and the production floor. For their part, production engineers are very concerned with such aspects of PLD programmers as ease of use, throughput, and methods of updating the programmer to accommodate new devices.

Design engineers, on the other hand, don't have to worry that the operator interface is simple enough to be

TABLE 1—PLD PROGRAMMERS

MANUFACTURER	MODEL	UNIVERSAL	PLD ONLY	FAMILY MODULES	DEVICE PINS	TESTS*	COST**	COMMENTS	READER SERVICE NO
ALTERA CORP 3525 MONROE ST SANTA CLARA, CA 95051 (408) 984-2800, TLX 888496	MHP		•	•			$1995	PROGRAMS ONLY ALTERA EP SERIES PLDs.	CIRCLE NO 650
BYTEK CORP 1021 S ROGERS CIRCLE BOCA RATON, FL 33431 (305) 994-3520	S5-AD		•		20, 24	S, D, V	$995	NOT UPGRADABLE; DEVICE LIST FROZEN.	CIRCLE NO 651
	125-AD		•	•	20, 24	S, D, V, P	$1395		
CYPRESS SEMICONDUCTOR CO 3901 N FIRST ST SAN JOSE, CA 95134 (408) 943-2653	QUICKPRO	•			20, 24, 28	S, D, V	$995	IBM PC PLUG-IN.	CIRCLE NO 652
DATA I/O CORP BOX 97046 REDMOND, WA 98073 (206) 881-6444, TLX 152167	29B	•		•	DIP≤84 CC†≤44	S, D, V, P, R	$5000–$8000		CIRCLE NO 653
	UNISITE 40	•			DIP≤40 CC≤40	S, D, V, P, R	$11,000		
	60A 60H		•	•	20, 24, 28	S, D, V	$2495 $4425		
DIGILEC INC 1602 LAWRENCE AVE OCEAN, NJ 07712 (201) 493-2420	803-LDC1,2,3		•		20, 24, 28	S, D, V, P, R	$3550–$3630	BUILT-IN CRT, PALASM, DISASSEMBLER, IFL ASSEMBLER.	CIRCLE NO 654
	860		•		DIP≤40 CC≤44	S, D, V, P	$1995		
DIGITAL MEDIA 11770 WARNER AVE, STE 225 FOUNTAIN VALLEY, CA 92708 (714) 751-1373	IQ-180	•			20, 24, 28	S, D, V, P	$1995		CIRCLE NO 655
	IQ-280	•			≤40	S, D, V, P	$2995		
ELAN DIGITAL SYSTEMS 720 N FAIROAKS AVE, #91 SUNNYVALE, CA 94086 (415) 964-5338	UNIVERSE 1011		•		20, 24	S, D, V	$2495	DOES SELF TEST BEFORE ANY OPERATION THAT AFFECTS THE PLD. CAN UPGRADE TO UNIVERSAL PROGRAMMER.	CIRCLE NO 656
EXEL MICROELECTRONICS INC 2150 COMMERCE DR SAN JOSE, CA 95131 (408) 942-0500 TWX 910-338-2116, TLX 171339	E²PRO		•				$749	78C800 ONLY. INCLUDES ABLE-COMPATIBLE SOFTWARE AND THREE BLANK DEVICES.	CIRCLE NO 657
GTEK INC DRAWER 1346 399 HIGHWAY 90 BAY ST. LOUIS, MS 39520 (601) 467-8048, TLX 315814	7344		•		20, 24	S, D, V	$995	DOES NOT PROGRAM SHARED-PRODUCT PLDs. BIPOLAR ONLY. BUILT-IN PALASM-LIKE SOFTWARE.	CIRCLE NO 658
INLAB INC 2150-I W 6th AVE BROOMFIELD, CO 80020 (303) 460-0103, TLX 797159	28L		•		20, 24, 28	S, D, V, P		PROGRAMMER UPGRADABLE TO UNIVERSAL.	CIRCLE NO 659
INTEL CORP 151 BLUE RAVINE RD FOLSOM, CA 95630 (916) 351-8080	iUP-IC		•		≥44		$3450	PRICE INCLUDES PLD DEVELOPMENT SOFTWARE. IBM PC PLUG-IN. ALTERA/INTEL EP SERIES ONLY.	CIRCLE NO 660
INTERNATIONAL MICROSYSTEMS INC 790 E ARQUES AVE SUNNYVALE, CA 94086 (408) 245-7180	ECL-1		•		24		$495	ECL PALs ONLY.	CIRCLE NO 661
	ECL-2		•		24	S, D, V, P	$695	ECL PALs ONLY.	
KONTRON ELECTRONICS 633 CLYDE CT MOUNTAIN VIEW, CA 94039 (415) 965-7020, TWX 910-378-5207	EPP-80 MPP-80S	•		•	20, 24, 28, 40	S, D, V	$6028–$6795	EPROM BACKUP OF JEDEC FILE. MPP-80S IS PORTABLE VERSION OF EPP-80.	CIRCLE NO 662
LOGICAL DEVICES INC 1321 NW 65th PL FORT LAUDERDALE, FL 33309 (305) 974-0975, TLX 383142	ALL PRO	•			DIP≥40	S, D, V	$2900	DOES PARAMETRIC TESTS. COMES WITH PLD SOFTWARE. NEEDS PC.	CIRCLE NO 663
	PROMPRO-8X	•			20, 24	S, D, V	$985		
	PALPRO-2X		•		20, 24	S, D, V	$1295		
MICROWAY BOX 79 KINGSTON, MA 02364 (617) 746-7341	PC-PAL		•		20, 28		$395	IBM PC PLUG-IN. MMI PALs ONLY.	CIRCLE NO 664

*S = SELF TEST; D = DEVICE BLANK, ORIENTATION; V = VECTOR TEST; P = PRELOAD TEST; R = PSEUDORANDOM VECTOR TEST.
**PRICES ARE FOR UNIVERSAL PROGRAMMERS AS CONFIGURED FOR PLD PROGRAMMING; CONFIGURING SOME UNIVERSAL PROGRAMMERS TO HANDLE PROMs AND SINGLE-CHIP μPs, AS WELL AS PLDs, CAN INCREASE THEIR PRICES.
†CHIP CARRIER.

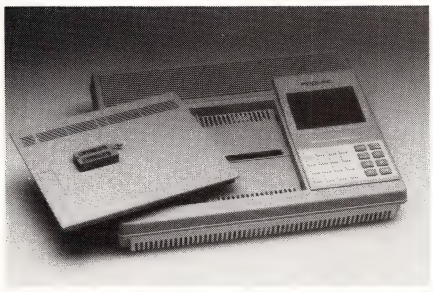
Table continued on pg 124

TABLE 1—PLD PROGRAMMERS *(Continued)*

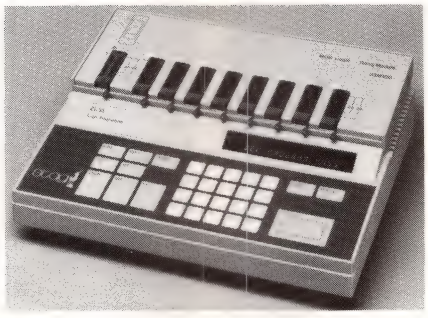
MANUFACTURER	MODEL	UNIVERSAL	PLD ONLY	FAMILY MODULES	DEVICE PINS	TESTS*	COST**	COMMENTS	READER SERVICE NO
NICOLET TEST INSTRUMENTS DIV 215 FOURIER AVE FREMONT, CA 94539 (415) 490-8870	NIC-PAL II		•		20, 24, 28	S, D, V	$1295	REQUIRES PC.	CIRCLE NO 665
OLIVER ADVANCED ENGINEERING INC 320 W ARDEN ST GLENDALE, CA 91203 (818) 240-0080 TWX 510-600-8099	OMNI 28	•			≥28	S, D, V, P	$2995	REQUIRE CRT OR PC. DO PARAMETRIC TESTS. OMNI 28, 40 UPGRADABLE.	CIRCLE NO 666
	OMNI 40	•			≥40		$3995		
	OMNI 64	•			≥64		$4995		
ONE/D 1050 E DUANE AVE SUNNYVALE, CA 94086 (415) 969-9000	SAILOR-PAL		•		20, 24, 28, 32	D, V, P	$975	REQUIRES IBM PC. LOTUS 1-2-3 USER INTERFACE.	CIRCLE NO 667
PROGRAMMABLE LOGIC TECHNOLOGIES INC BOX 1567 LONGMONT, CO 80501 (303) 772-9059	LOGIC LAB		•		20, 24		$479	PRICE INCLUDES SOFTWARE. HANDLES GALs ONLY.	CIRCLE NO 668
PROMAC PROGRAMMING INSTRUMENTS INC 2999 MONTEREY/SALINAS HWY MONTEREY, CA 93940 (408) 373-3607, TLX 882141	P3		•		20, 24, 28	S, D, V, P	$2695	EPROM MASTER OF JEDEC FILE. REQUIRES CRT TO USE BUILT-IN PALASM II, SIMULATOR, AND VECTOR GENERATOR.	CIRCLE NO 669
	P11	•			≥84	S, D, V, P	$3595		
	P2A	•			≥40	S, D, V	$1595		
QWERTY INC 5346 BRAGG ST SAN DIEGO, CA 92122 (619) 455-0500	GPR-1000		•		20, 24	S, D, V, P	$995	GALs ONLY. ACCEPTS JEDEC FILES FOR CONVENTIONAL PALs. HAS FUSE DECOMPILER.	CIRCLE NO 670
ROYAL ELECTRONICS 1314 KILBORN AVE OTTAWA, ONT, CANADA K1H 6L3 (613) 738-1200 FAX (613) 738-1202	EV 6000		•		20, 24	S, D	$795	GAL ONLY INCLUDING 39V18. NEEDS IBM PC. PRICE INCLUDES PALASM-LIKE ASSEMBLER AND MULTI-PLD SIMULATOR.	CIRCLE NO 671
STAG MICROSYSTEMS INC 1600 WYATT DR SANTA CLARA, CA 95054 (408) 988-1118	ZL30A		•		20, 24, 28	S, D, V, P	$2850–$3495	REQUIRES CRT TO EDIT FUSE MAP. EPROM JEDEC MASTER.	CIRCLE NO 672
	ZL33		•		20, 24	S, D, V, P	$3495	8-DEVICE GANG BIPOLAR PROGRAMMER.	
	PPZ	•		•	≥40	S, D, V, P	$6490–$7500	BUILT-IN CRT. LIGHT PEN, PALASM-LIKE SOFTWARE OPTIONAL. TWO RS-232C PORTS.	
SUNRISE ELECTRONICS INC 524 S VERMONT AVE GLENDORA, CA 91740 (818) 914-1926 TWX 510-601-1165	Z1000B	•			≥40	S, D, V, P	$4495	TWO RS-232C PORTS. EPROM JEDEC MASTER. $1998 MODULE REQUIRED FOR MEGAPALs.	CIRCLE NO 673
SYSTEM-GENERAL CO 3rd FL, #6, LANE 4 TUN HWA N RD TAIPEI, BOX 53-591 TAIWAN, ROC (02) 721-2613, TLX 13810 FAX (02) 721-2615	SGUP-85	•		•	20, 24, 28	S, D, V, P	$2995		CIRCLE NO 674
VALLEY DATA SCIENCES CHARLESTON BUSINESS PARK 2426 CHARLESTON RD MOUNTAIN VIEW, CA 94043 (415) 968-2900, TLX 4993461	VDS160	•			≥40	S, D, V, P	$4995	PRICE INCLUDES SOME PLD SOFTWARE. REQUIRES PC.	CIRCLE NO 675
VARIX CORP BOX 850605 RICHARDSON, TX 75085 (214) 437-0777	SPO300	•			≤40	S, D, V, P	$3800–$4600	CAN EXPAND TO 80 PINS.	CIRCLE NO 676
	GP1140	•			≤40	S, D, V, P	$4800–$5600	REQUIRE PC. GP1140 IS GANG PROGRAMMER.	

*S= SELF TEST; D = DEVICE BLANK, ORIENTATION; V = VECTOR TEST; P = PRELOAD TEST; R = PSEUDORANDOM VECTOR TEST.
**PRICES ARE FOR UNIVERSAL PROGRAMMERS AS CONFIGURED FOR PLD PROGRAMMING; CONFIGURING SOME UNIVERSAL PROGRAMMERS TO HANDLE PROMs AND SINGLE-CHIP μPs, AS WELL AS PLDs, CAN INCREASE THEIR PRICES.
†CHIP CARRIER.

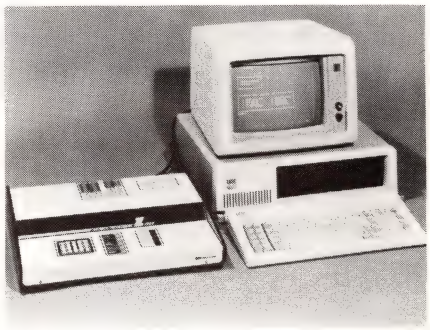
PLDs strain the engineering capabilities of PLD-programmer makers as they try to keep up with PLD makers.



Not all PLD-programmer makers have embraced the idea *of handling all devices in a single unit. Promac's P11 universal programmer still employs family modules to accommodate different classes of programmable devices.*



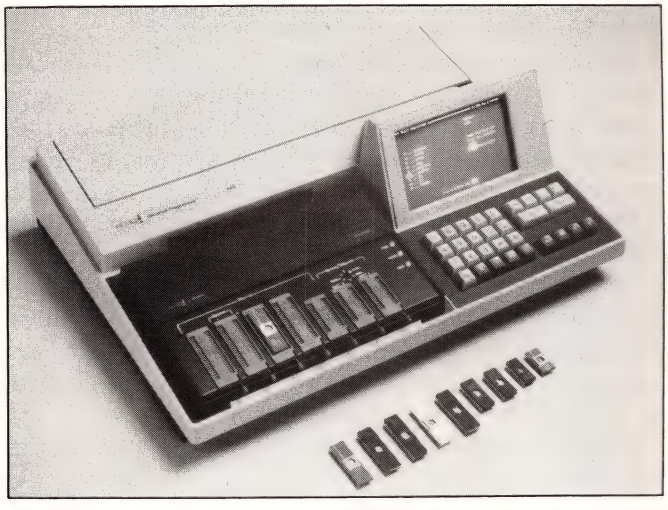
One of the two gang programmers for PLDs *currently on the market is the Stag Model ZL33. Other programmer makers are waiting for a larger market to develop before they'll deploy gang PLD programmers.*



You can operate all universal programmers, *like this Sunrise Model Z1000, as standalone units, or you can drive them with an IBM PC.*

used by an untrained worker who, perhaps, understands little English. Nor do design engineers program enough devices to worry about throughput. And although design engineers might prefer to update their PLD programmers with software, as Digital Media's IQ-180 and IQ-280 allow you to do, they experience little difficulty in dealing with the more common method of updating a PLD programmer—opening it up and exchanging outdated PROMs for new ones.

Testing, however, is a production-related aspect of PLD programmers that requires specific input from the designer. Design engineers would therefore do well to consider the testing capabilities of PLD programmers. These programmers can shoulder more of the testing burden than designers suspect, and as a result they can affect the overall testing strategy.



When equipped with an optional light pen, *the Stag PPZ universal programmer can function as a stand-alone PLD-development station, because it has a built-in Palasm-like compiler and a fuse-map editor.*

PLD-programmer makers report a complete spectrum of test strategies employed by their customers. At one end of the spectrum are PLD users who do no testing at all, even though most PLD programmers have modest, but useful, device-testing abilities. At the other end, large companies like DEC subject every PLD to complete ac and dc parametric testing on a separate piece of production-test gear after burning the device in a programmer.

Limited choice for parametric tests

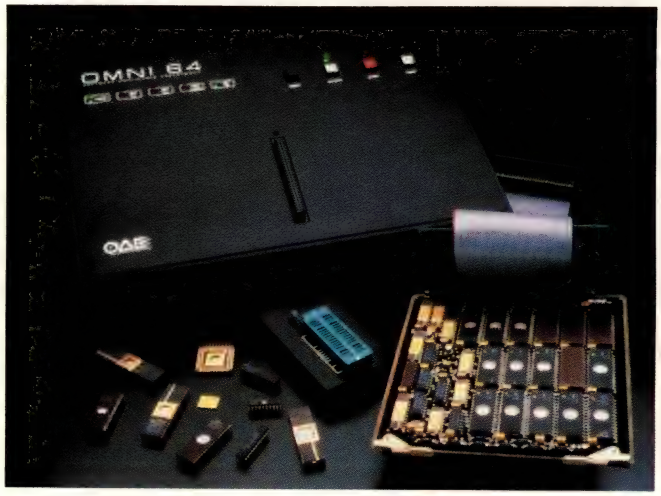
Only two PLD-programmer makers offer anything other than low-speed functional tests. Oliver Advanced Engineering's programmers can perform ac parametric tests for specs such as propagation delay to 1-nsec resolution. Logical Devices' Allpro can perform dc parametric tests of such device characteristics as input hysteresis, output leakage, and fan-out capability. Users of other brands of PLD programmers will have to rely on other production-test gear for parametric testing.

Of course, not every company can afford the kind of production-test gear that a company the size of DEC can. Smaller companies must depend on less strenuous —and less expensive—functional testing. They reason, based on their experience with PROMs, and quite rightly, that if a device can pass a low-speed functional test, then it will most likely perform correctly at full speed in the circuit.

Some PLD-programmer users, however, misapply their experience with burning PROMs. Where they go wrong is in assuming that verifying the fuse map of their PLDs is equivalent to doing a functional test. Such is the case for a PROM; once you've verified that

Some PLD makers are attempting to shift back some of the burden of PLD-programmer certification.

Targeted at the needs of electronics designers, *the Logical Devices Allpro universal programer requires an IBM PC for operation and runs the company's companion PLD-design software.*



Only two PLD-programmer makers have products *that perform parametric as well as dc functional tests. One of these companies, Oliver Advanced Engineering, offers the Omni Series of programmers, which do ac parametric tests for such specs as propagation delay to 1-nsec resolution.*

all the PROM's memory locations will read out the correct, expected data, you have done a functional test. Not so for a PLD.

Quite simply, there's more to a PLD than its fuse map. Performing a functional test on a PLD involves stimulating the device with a series of inputs—or vectors—and checking the device's outputs against a list of expected outputs.

Design engineers are obviously a company's best source of test vectors. After all, the designer best understands how his PLDs work. The design engineer's input is especially necessary for testing PLDs with buried state registers. These tests are called "preload" tests.

Preload testing does not, as the term suggests, test the preload function of a PLD's flip-flops. Rather, the term refers to the initialization of the registers in a PLD to a known state before the application of a sequence of test vectors. Initializing registers is essential if the PLD is a state machine and not just a combinatorial design.

It's worth noting that, although PLD programmers can do preload testing, there's no finalized standard for the test, so you must pay attention to each programmer's peculiarities. The JEDEC Committee on Standard Data Transfer Format Between Data Preparation System and Programmable Logic Device Programmer, headed by Michael J Holley of Data I/O's FutureNet subsidiary, is currently drafting a new version of JEDEC Standard No 3-A, which will clear up some problems with the earlier standard and add a section to standardize preload testing. (The JEDEC file often referred to in PLD-programmer literature is the part of this committee's JEDEC standard that specifies the content of the programming and testing information sent to a PLD programmer from a host and that specifies the protocol for its transmission. The file contains a header identifying the part to be programmed, the fuse map, and—optionally—test vectors.)

How the PLD programmer can help

PLD programmers can test PLDs both before and after programming. Before programming a device, a programmer can perform a self-test to ensure that its programming, or "super," voltages are correct. Most programmers do a self-check upon power-up. The Elan Universe 1011 can repeat the test upon command and before programming each device.

Next, after you plug in a PLD to be programmed, most programmers can check the PLD to be sure that it's blank and plugged in correctly. Some programmers can also interrogate certain PLDs and verify that you've plugged in the proper type of PLD.

After programming the PLD, most programmers can verify the fuse map and apply a set of test vectors to the device. Data I/O's Unisite 40, 29B, and 60 programmers and Digilec's Model 803 can apply a set of pseudo-random vectors to a PLD and compress the resulting outputs into a signature with a data-reduction algo-

Digital Media's IQ-180
Ten times smaller than the current generation of bench-top programmers. The model IQ-180 offers function and intelligence not found in programmers costing three times as much. It programs PLDs, PLEs, IFLs, PROMS and EPROMS from one universal socket.

No other programmer can match the IQ-180's performance, reliability, compactness or superior design. It is the least expensive programmer in its class. Designed to handle the biggest job yet priced for the smallest budget.

Time is money-Speed is profit
No programmer programs as fast. Driven by a proprietary high-speed circuitry and a single chip micro, the IQ-180 will surprise you with its responsiveness, all while maintaining the manufacturers specified programming integrity. The speed of its PLD programming, functional testing and verification is an industry standard which has never been equaled.

Peace of Mind through intelligence
You can rest assured that the IQ-180 will always perform reliably and at maximum yield. This "intelligent" unit was designed to self-calibrate and check itself on power-up and on all "GO" commands.

Single or Engaged
You can use your unit as a complete stand alone programmer or connect it to a terminal, personal computer or mainframe through the built-in serial interface. You will have full data and file manipulation.

Simple to use
It can't get much easier. To prepare the IQ-180 for the correct algorithm simply select the part number from the menu, and the programmer does the rest. Also at the touch of a button, a batch command called DMatic™ executes a sequence of read, blank-check, verify, program, verify, test and secure commands.

Compatibility
The IQ-180 is completely compatable and versatile enough to be used with all the popular logic design and simulation software like ABLE™, CUPL™, PALASM™ and others.

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Telex #990499
CIRCLE NO 116

Testing is a production-related aspect of PLD programmers that design engineers would do well to consider.

You can update this PLD programmer, *the Inlab Model 28, to universal-programmer status in the field.*

rithm somewhat similar to a cyclic-redundancy-check (CRC) algorithm. Upon completion of the test, the signature should match a signature obtained from a PLD that's known to be good. Data I/O's scheme relieves the user of the chore of developing a suite of test vectors.

To make testing easier, the PLD designer can, in some cases, bring out Preset or Clear lines of a PLD's registers to an external pin. Or the designer can connect them to a product term, depending on the PLD's architecture. In other cases, however, the PLD's registers may be completely "buried" and inaccessible to the device's input pins when the chip is in its normal mode.

Fortunately, all but the oldest PLDs give you access to buried state registers by putting the chip into a special mode—usually by impressing super, or higher than normal, voltages on certain pins. Because PLD programmers have the programmable high-voltage drivers needed to program PLDs, they can easily be programmed to initialize buried registers as well.

Without initialization, you cannot predict how your state-machine PLD will react to a given set of test vectors. The buried registers' outputs are inputs to the PLD's logic just like the test vectors impressed on the PLD's input pins. At power-up, the buried state register assumes some random initial state. Therefore, because not all the inputs to the PLD are determinate, you can't predict the output unless you get the buried registers to a known state.

Testing is still important today, even though PLD makers now report yields in the range of 98% to 99%. Yet a yield figure is an average over time. In the short term, you're likely to encounter bad batches of devices that exhibit very low yields interspersed with batches that are virtually 100% good. And of course, makers of bipolar and ECL PLDs don't even enjoy the erasable-PLD makers' advantage. They must ship their devices unprogrammed. Therefore, you can't be 100% sure of such a device until after you've programmed it yourself.

Beyond the issues of device coverage and device testing, you might consider the architectures of various programmers. Although PLD programmers have a great variety of architectures, you can drive virtually all programmers from an IBM PC. In addition, some have a pair of RS-232C ports that allow you to operate the programmer in series with your terminal in a "transparent" mode; transparent-mode operation comes in handy if you do your development work on a terminal attached to a mainframe.

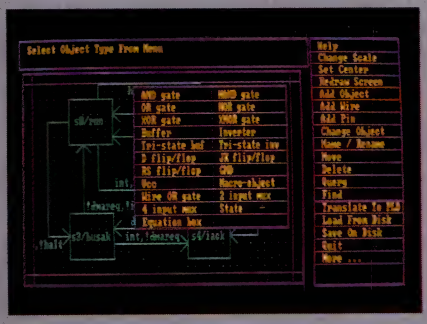
When used in these modes, all PLD programmers function similarly no matter which architecture they have. When operating as stand-alone units, however, PLD programmers do exhibit significant differences.

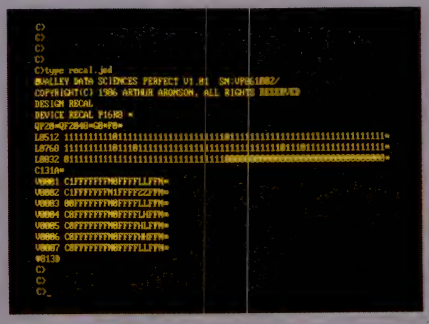
In addition to distinguishing between universal and dedicated PLD programmers, you can also separate PLD programmers into stand-alone programmers and programmers that require a computer or terminal for operation—a distinction that admits of degrees. Some units, like the Varix SPO300, the Gtek 7344, and the

Text continued on pg 132

Take PLD/PROM Design Concepts To Programmed Results

(For PC Based PLD/PROM Programmer & Software Design Tools)





Vista

Graphic Design Software

Vista turns your PC into a Graphic Work Station for PLD design using your preferred choice of Gate Level Schematic entry, State Machine Diagrams, or Boolean Equations.

Vista reduces the likelihood of errors that may occur during the design input process. You can mix State Machine, Gate Level Schematic, and Boolean Equations in the same design. Then pass this information to the VDS Perfect compiler.

Perfect

Compiler/Minimizer/ Simulator

Perfect accepts input from text files containing State Machine Syntax, Truth Table, Vista Net-List, or Boolean Equations. After compiling and minimizing, it outputs JEDEC Fuse Files, Net-Lists, and other support documentation.

Other powerful features include: Timing Simulation, and Back Annotation - from JEDEC Fuse Files to Boolean Equations.

VDS160

Logic & Memory Programmer

PLD and PROM Programming from the original software controlled PROM programmer manufacturer. The **VDS160** menu-driven programming software presents an easy-to-learn interface for the user.

Features include: Concurrent Operation of VDS160 and PC programs, Pop-Up Menus, Editor for Fuse/Data Files. New Device Support is easily accomplished via floppy diskette updates.

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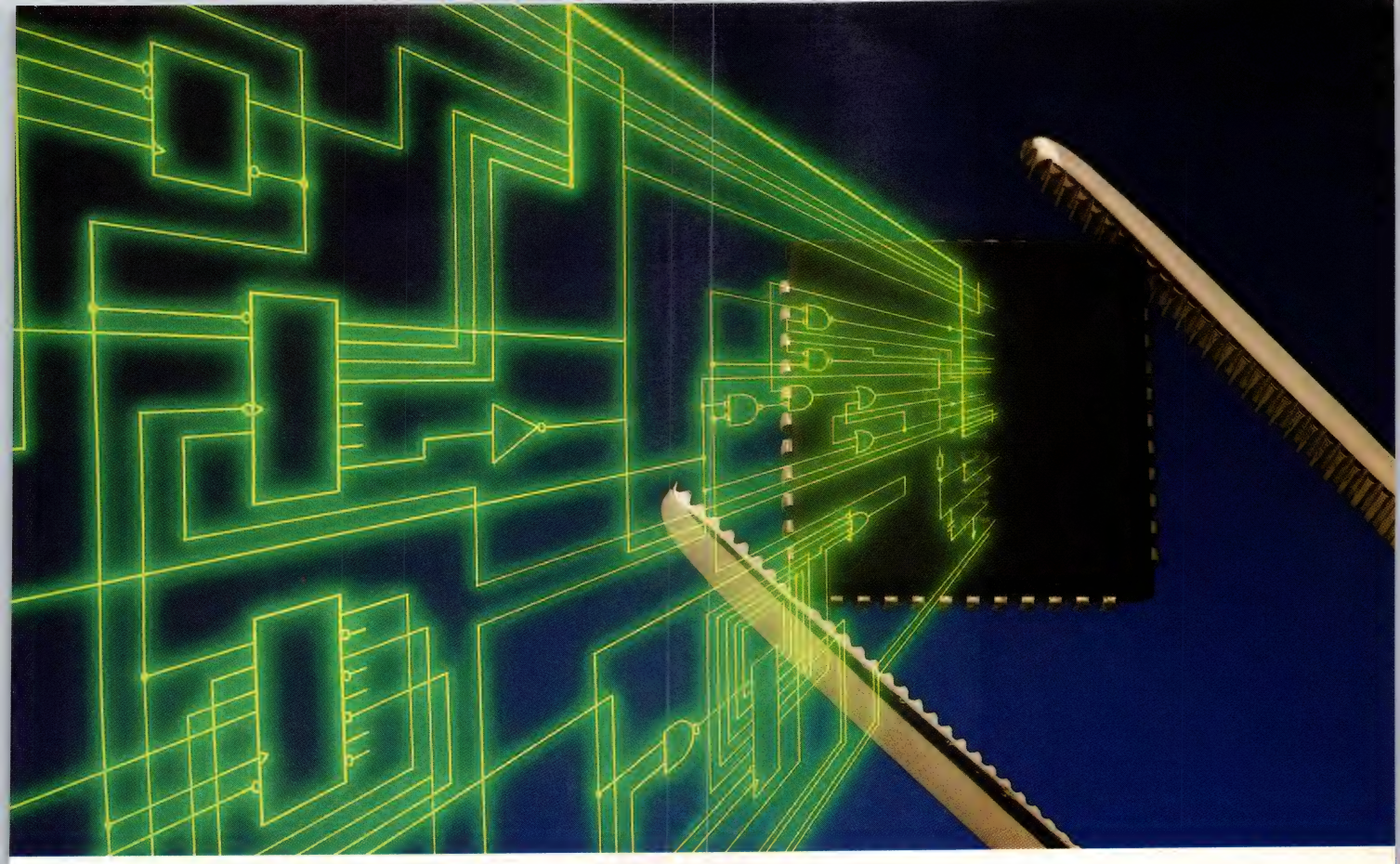
Germany (Macrotron) 89-4208100 **France** (Tekelec) 1-4547535 **Sweden** (Aktiv) 8-7390045 **Denmark** (C-88) 2-244888
England (DataTranslation) 734-793838 **S.A.** (Promilect Pty) 11-789-1400

CIRCLE NO 120

TABLE 2—COVERAGE OF SELECTED DEVICES

MANUFACTURER	MODEL	20-, 24-PIN BIPOLAR PALs	20-, 24-PIN CMOS PALs	IFL: FPLA, FPLS	ECL PALs	22V10	MEGA-PAL 32R16	ALTERA EP SERIES	ATMEL V750	EXEL ERASIC 78C800	SIGNETICS PML	LATTICE GALs	CYPRESS CMOS PALs
ALTERA	MHP							•					
BYTEK	S5-AD	•											
	125-AD	•		U		•		U			U	U	U
CYPRESS	QUICKPRO												•
DATA I/O	29B	•	•	•	•	•	•	•	U	•		•	•
	UNISITE 40	•	•	•	•	•	•	•	U	•	•	•	•
	60	•										•	•
DIGILEC	803-LDC1,2,3	•	•	•	•	U		•	U	U	U	•	•
	860	•	•	•	•	U		•	U	U	U	•	•
DIGITAL MEDIA	IQ180	•	•	•	•	•		•	•			•	•
	IQ280	•	•	•	•	•	•	•	•		•	•	•
ELAN	UNIVERSE 1011	•	•	•	•	U	U	•	U			U	•
EXEL	E²PRO									•			
GTEK	7344	•						•					•
INLAB	28L	•	•	•	•	•		•				•	•
INTEL	iUP-IC							•					
INTERNATIONAL MICROSYSTEMS	ECL-1,2				•								
KONTRON	EPP-80/ MPP-80	•	•	•		•	•	U				U	•
LOGICAL DEVICES	ALLPRO	•	•	•	•	•	•	•	U	U	•	•	•
	PROM-PRO-8X	•						•				•	
	PALPRO 2X	•						•				•	
MICROWAY	PC-PAL	•											
NICOLET	NIC-PAL II	•	•					•				•	•
OLIVER	OMNI 28	•	•	•	•	•	•	•	•	•	•	•	•
	OMNI 40	•	•	•	•	•	•	•	•	•	•	•	•
	OMNI 64	•	•	•	•	•	•	•	•	•	•	•	•
ONE/D	SAILOR-PAL	•	•					•				•	•
PROGRAMMABLE LOGIC	LOGIC LAB											•	
PROMAC	P3	•	•	•		•		•				•	•
	P11	•	U	•	U	•	U	•	U	U	U	•	•
	P2A							•				•	•
QWERTY	GPR-1000											•	
ROYAL	EV6000											•	
STAG	ZL30,A	•	•	•	•	•		•		U		•	•
	ZL33	•		•									
	PPZ	•	•	•		•	•	•		U		•	•
SUNRISE	Z1000B	•	•	•	•	•							
SYSTEM GENERAL	SGUP-85	•	•	•									
VALLEY DATA SCIENCES	VDS 160	•	•	•		•	•	•				•	•
VARIX	SP0 300	•	•	•	•	•	•	•				•	•
	GP 1140	•	•	•	•	•	•	•				•	•

U = UNDER DEVELOPMENT; TO BE IN NEXT SOFTWARE UPDATE.
NOTE: A PROGRAMMER MAY NOT HANDLE ALL DEVICES IN A SERIES. CONTACT MANUFACTURERS FOR EXACT, UP-TO-DATE LISTS OF COVERED DEVICES.



THE FIRST PROGRAMMER WITH A SINGLE SITE FOR EVERY DEVICE.

NEW UNISITE 40 HANDLES LEADING-EDGE DEVICES WITH SPEED AND EASE. Now you can program and test the latest programmable devices and packages, fast and accurately — all in a single site. The first true universal pin drivers support any device of a given package type in the same site. The UniSite™ 40's single DIP socket handles any device up to 40 pins, including PLDs, PROMs, IFLs, FPLAs, EPROMs, EEPROMs, and microcontrollers. The same site accommodates the most popular PLCCs and SO packages. A 16-bit processor, coupled with custom ICs and high-speed RAM, set new speed records for programming and testing.

TIMELY ACCESS TO TOMORROW'S DEVICES. With universal pin driver electronics hardware, device-specific instructions can be loaded from one

3½" micro-diskette. When new devices are introduced, you simply load a new master diskette, and the UniSite 40 is quickly updated.

MENUS MAKE PROGRAMMING EASY. Use your cursor to select any function. Menus prompt you step-by-step and HELP messages assist you throughout operation. A built-in listing of devices speeds part selection. The UniSite 40 can even save your most frequently used parameters for instant recall.

SHORTCUTS SPEED SETUP. More frequent users can bypass menus and zoom directly to specific operations by selecting key commands. Special software commands, like the ones in our QuickCopy™ mode, are also available to streamline your programmer operation.

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DATA I/O

Valley Data Sciences VDS 160, can't operate at all without an IBM PC. In fact, the Varix SPO300 has no memory, no processor, and no firmware; it's purely a dumb programming head that's under complete control of the PC. Other programmers, like the Oliver Omni series and the Inlab Model 28L, require at least a dumb terminal to operate as stand-alone units.

Most PLD programmers reveal their production-oriented heritage by having some sort of built-in control keyboard and display. These units can operate without any outside agency for control. Not all are completely stand-alone programmers, however. Most still need to get the fuse map and test vectors from some outside source.

Some can copy a device that's known to be good (assuming its security fuse isn't blown)—just as any PROM programmer can. Further, the Stag ZL30A, the Kontron EPP-80 and MPP-80, and the Sunrise Z1000B all have the ability to burn a complete JEDEC file into an EPROM. Subsequently, this EPROM can serve as a master, and the programmer will not have to retrieve the JEDEC file from a computer each time you want to program that particular device. (What, if any, use design engineers would make of this feature is debatable.) The Data I/O Unisite has its own built-in miniflopy drive and hence requires no external source of device files.

Of course, to the design engineer, stand-alone operation means more than just burning devices or being able to get a JEDEC file into the programmer without a computer link. Some programmers can also serve as a complete development station for PLDs. The Digilec Model 860, the Promac P3 and P11, and the Stag PPZ have built-in Palasm or Palasm-like compilers and fuse-map editors. What's more, the 860 has a fuse-map decompiler that reconstructs Boolean equations from a programmed PLD. Promac's units include a PLD software simulator and test-vector generator. The PPZ features an optional light pen that allows you to program on the unit's built-in CRT without the aid of a keyboard or terminal.

The built-in development capabilities of these programmers don't offer all the fancy features of third-party PLD-development packages like Abel and CUPL. Depending on your application, however, you may find these programmer's simple tool sets perfectly adequate. **EDN**

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

Keep Time

Keeping track of human time hasn't been easy for computer systems. Until now.

The SmartWatch DS1216 and DS1216E from Dallas Semiconductor reports the hour, day, month and year, down to the one hundredth of a second. With the SmartWatch any system can tell time.

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CIRCLE NO 117

Schroff

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Yet, the Europac subrack is competitively priced. It's as flexible as it is affordable. It is available with a selection of accessories that cannot be matched and meets all applicable EIA, IEC, DIN and IEEE standards.

For all these reasons, Europac is the number one subrack in the world. Which is also why it should be number one with you.

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CIRCLE NO 118

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4-CHANNEL DIGITAL OSCILLOSCOPE FOR PC'S
ONLY $1995!

The 4X4 is the first technically superior digital oscilloscope peripheral for IBM PC, XT, AT and compatibles. *No programming required.*

Sample 4 Channels Simultaneously.

The 4X4 has 4 analog-to-digital converters allowing 4 separate and individual channels to be captured or sampled at the same time. Four simultaneous channels are unique in the industry, and powerful in mutiple channel applications.

Highest Sample Rate Per Channel In The Industry For The Price.

The 4X4 allows a sample rate for each channel to be as high as 500 KHZ. Most other products divide the sample rate among the number of channels reducing the sampling rate. For example, an 8 channel board with one 100KHZ A/D converter has a sample rate of 12.5KHZ per channel.

Largest Buffer Size For 4 Channels In The Industry.

The data buffer is a block of memory where the sampled data is stored as the input signal is being digitized by the A/D converter. The 4X4 has the largest buffer size (32,760 eight bit words) for 4 channels in the industry. The total data buffer size is 128k.

The larger the data buffer, the longer in time that the input signal can be sampled. The buffers allow the user to view 4 channels at the same time with the screen display showing between 0.5msec (fastest sample rate) and 48 minutes (slowest sample rate) worth of data for each channel. The buffer will hold 3.8 days of data at the slowest sample rate.

Unique Software Features.

The 4X4 provides completely turnkey digital oscilloscope software:

- ☐ Cursor.
- ☐ X versus Y display.
- ☐ Print/save/retrieve/overlay waveforms.
- ☐ Active scrolling.
- ☐ Online help screens.
- ☐ 1 to 2000 zoom mode.
- ☐ Store/retrieve/control setups.
- ☐ Menu driven operation.
- ☐ Turnkey FFT software available.

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The 4X4's software programmable gain is particularly useful in automatic test and measurement applications and where test results are used to determine the gain range. Over 100db of input signal resolution means the user can resolve 1 mv to 500v p-p.

Plus, The Standard Oscilloscope Features You Would Expect In A Standalone Instrument.

- ☐ 1 Meg ohm 30pf input impedance.
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RAPID SYSTEMS

CIRCLE NO 119

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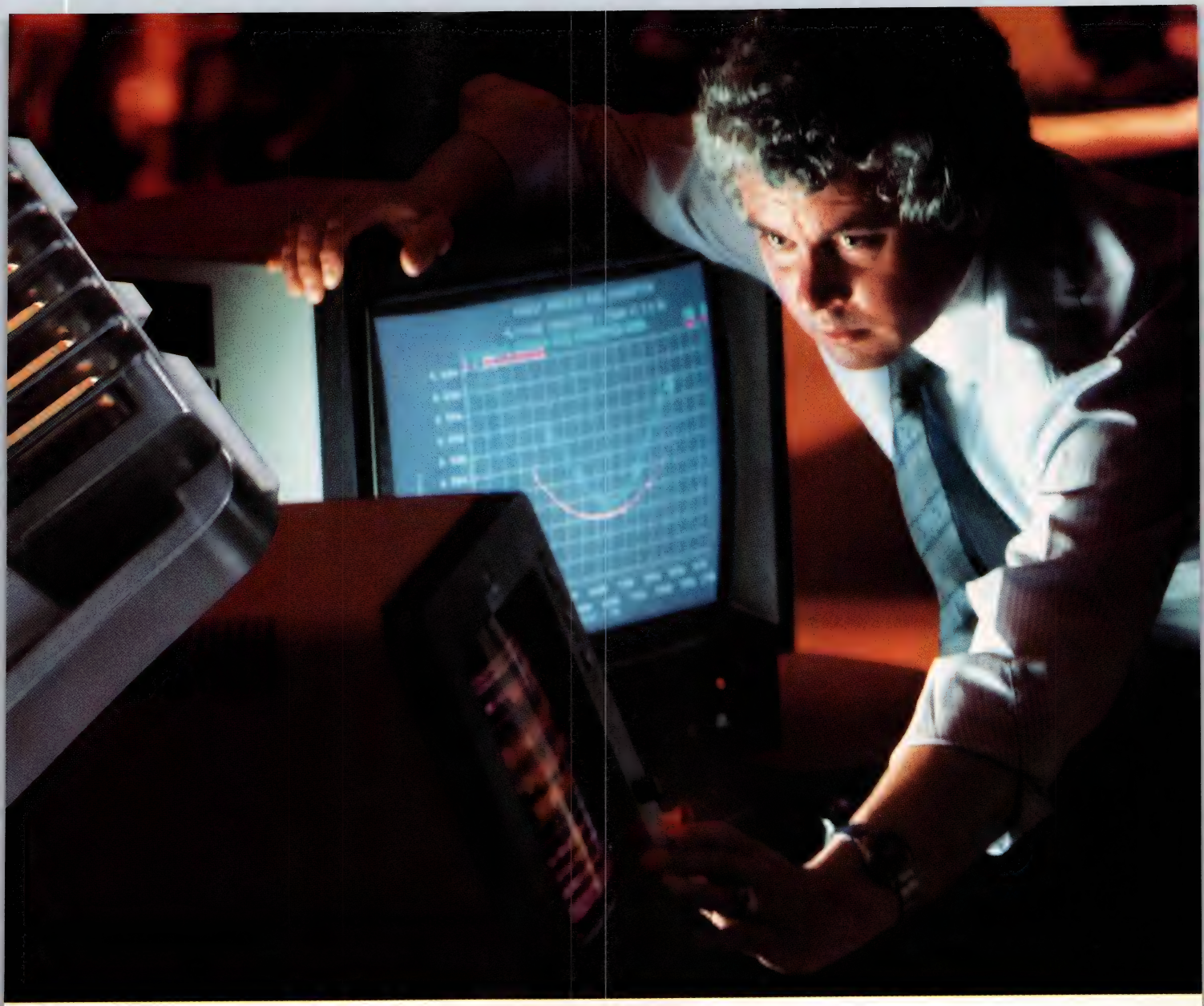
Round shielded cable terminates in just two steps. Optional insulation boot protects against ESD.



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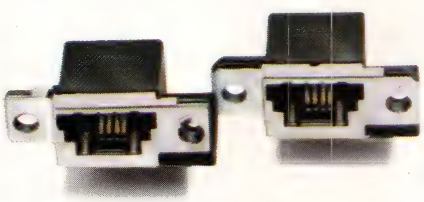
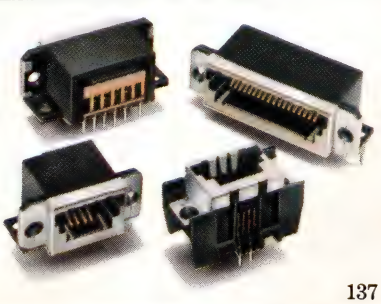
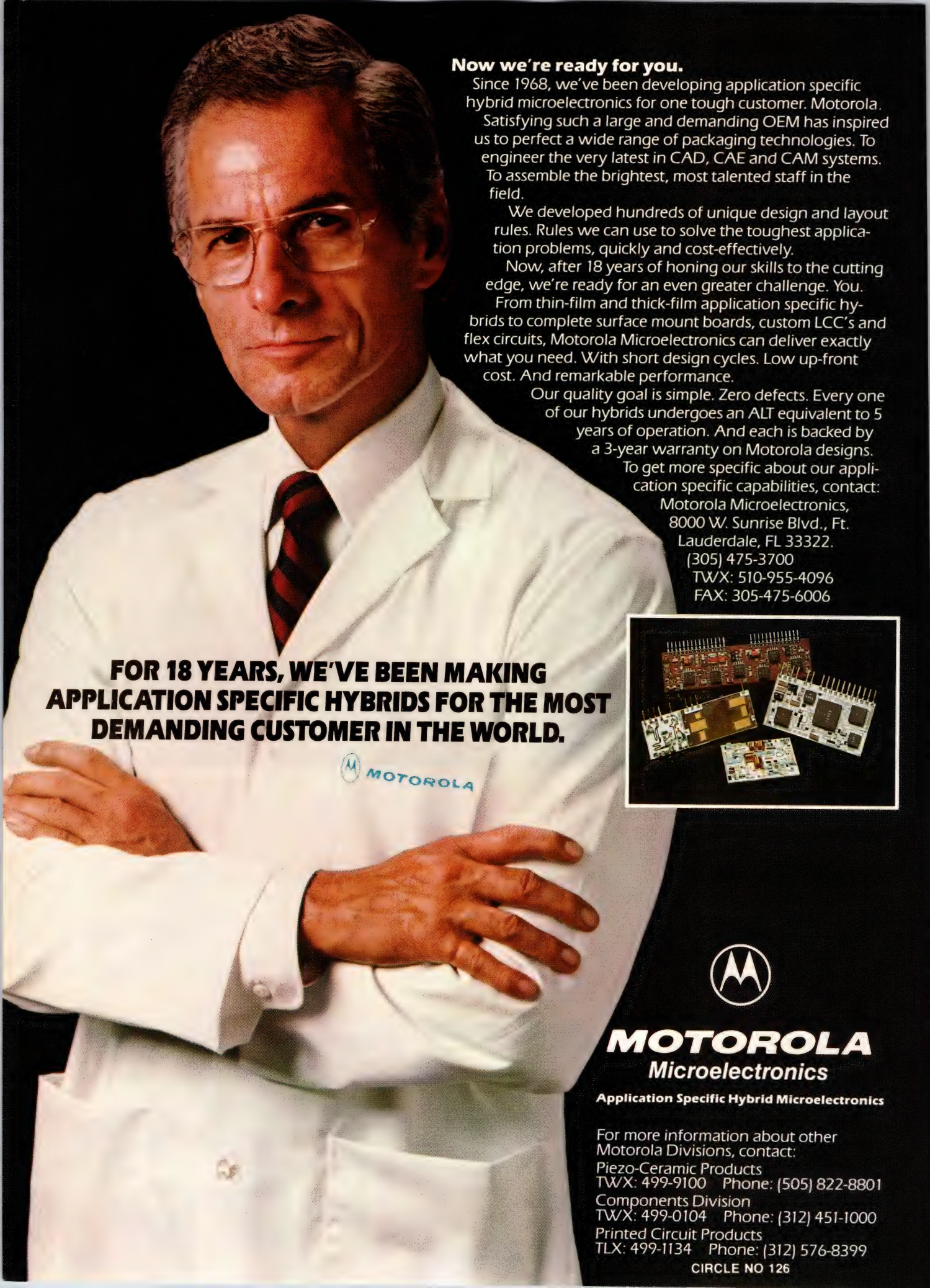


Top or side entry pcb receptacles. Integral shunt versions and side-entry versions with offset mounting ears for close spacing also available.



CIRCLE NO 125



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CIRCLE NO 126

Electro/87

Electro/87
Electro/87
Electro/87

Topics that will range from the social and ethical issues involved in engineering to the intricacies of current design technology will appeal to the specialist as well as the general practitioner in electronics.

Tom Ormond, *Senior Editor*

This year, the Electro/87 and Mini/Micro Northeast exhibits and sessions are under one roof at the Jacob Javits Convention Center in New York City. Between April 7 and April 9, you'll be able to examine companies' established products as well as their introductions at more than 700 exhibits; some of these devices are described starting on pg 144. What's more, you'll have the opportunity to attend the program of professional sessions, which will cover the gamut of state-of-the-art electronics technology.

Various sessions are dedicated to components such as gate arrays, PLDs, smart ICs, and LSI/VLSI. Other meetings will address advances in system architecture, logic, memory, processors, and number crunchers. Custom and semicustom design centers, tools, and design verification techniques will also be discussed; other sessions will delve into computer language, software-based systems, interface standards, and manufacturing technologies. Sessions on artificial intelligence will address the social implications of the technology. A panel discussion will cover the ethical issues you might face in the workplace. The sessions labeled as minitutorials will give overviews of emerging technologies and present guidelines on how to deal with some critical engineering problems.

If session emphasis is any indication of trends in electronics, then PLD technology is still a hot area. In **session 19,** you can learn about new alternatives in user-programmable PLDs. Six papers will explore the capabilities of PLDs, emphasizing the architectural innovations that have broadened their use.

Session 26 will discuss the benefits of PLDs in system design. The presentations will also explore recent PLD architectural advances and cover the viability of PLDs as semicustom substitutes. They will also detail software support tools for PLDs and how these tools help improve system designs.

Products that evolve from current designs will probably require even higher speeds, which will place severe demands on programmable logic. The presentations in **session 35** will illustrate how well the new generation of PLDs answers these demands. To round out the PLD program coverage, **session 23** will highlight programmable logic for the future.

Digital signal processing (DSP) is also a topic that will be well covered in this year's program. Single-chip programmable DSP devices are dramatically affecting the implementation of traditionally analog functions in

Electro/87 will highlight smart ICs and their applications in military, space, and commercial markets.

Electro schedule and registration information

Electro/87 will take place Tuesday, April 7, to Thursday, April 9, 1987, at the Jacob Javits Convention Center in New York City. Mini/Micro Northeast will run concurrently at the same location.

Registration at the door for the conferences is $10 for IEEE members and $20 for nonmembers. All Electro and Mini/Micro Northeast professional program sessions and minitutorials are included in the registration fees.

PROFESSIONAL-PROGRAM SESSIONS

DATE/TIME	ELECTRO	MINI/MICRO	MINITUTORIALS
APRIL 7 TUESDAY 10:00 AM TO 12:00 PM	SOCIAL IMPLICATIONS OF ARTIFICIAL INTELLIGENCE—SESSION 1	DESKTOP PUBLISHING BY ENGINEERS—SESSION 2	EVERYTHING YOU MIGHT NEED TO KNOW ABOUT METASTABILITY—SESSION 3
		MEMORY AND MEMORY SUPPORT—INNOVATIONS AND DEVELOPMENTS—SESSION 4	
1:30 PM TO 3:30 PM	SUPPORTING THE ETHICAL ENGINEER—SESSION 5	USING ADA IN REAL TIME APPLICATIONS—SESSION 6	GROUNDING AND SHIELDING ELECTRONIC INSTRUMENTATION—SESSION 8
		BUILDING NUMBER-CRUNCHERS WITH LSI DATA-PATH ELEMENTS I—SESSION 7	
4:30 PM TO 6:30 PM	TECHNOLOGY AND LAW—SESSION 9	RISCY BUSINESS—SESSION 10	
		BUILDING NUMBER-CRUNCHERS WITH LSI DATA-PATH ELEMENTS II—SESSION 11	
		CACHE MEMORY AND FIFO ARCHITECTURES FOR HIGH-PERFORMANCE COMPUTER SYSTEMS—SESSION 12	
APRIL 8 WEDNESDAY 10:00 AM TO 12:00 PM	AMERICAN MANUFACTURING: OUR COMPETITIVE EDGE—SESSION 13		FIBER OPTIC SENSOR TECHNOLOGY—SESSION 16
	ADVANTAGES OF ASIC DESIGN CENTERS—SESSION 14		
	ADVANCES IN CMOS STRUCTURAL SYSTEM DESIGN—SESSION 15		
1:30 PM TO 3:30 PM	OFFSHORE OPPORTUNITIES TO REDUCE COSTS AND EXPAND MARKETS INTERNATIONALLY—SESSION 17	NEW ALTERNATIVES IN USER PROGRAMMABLE LOGIC DEVICES—SESSION 19	CURRENT DIRECTIONS IN LIGHTWAVE COMPONENTS AND SYSTEMS—SESSION 20
	ANALOG DESIGN MADE EASY WITH CAE—SESSION 18		
4:30 PM TO 6:30 PM	ASSURING SUCCESS IN NEW VENTURES—SESSION 21	PROGRAMMABLE LOGIC FOR THE FUTURE—SESSION 23	OPTIMIZING SEMICUSTOM DESIGN—SESSION 22
	NEW APPLICATIONS FOR ELECTRO-OPTICAL COMPONENTS—SESSION 24		
APRIL 9 THURSDAY 10:00 AM TO 12:00 PM	DIGITAL SIGNAL PROCESSORS: PRODUCTS AND APPLICATIONS—SESSION 27	ADVANCES IN INNOVATIVE PLD ARCHITECTURE AND THEIR BENEFITS FOR SYSTEM DESIGN—SESSION 26	INTRODUCTION TO REALISTIC COMPUTER GRAPHICS—SESSION 25
		MULTIBUS II: THE MESSAGE PASSING COPROCESSOR (MPC) AND SYSTEM DESIGN—SESSION 28	
1:30 PM TO 3:30 PM	DESIGN AUTOMATION FOR INTEGRATED CIRCUITS—SESSION 30	NEW STANDARD DSP CHIPS ENHANCE TELECOMM DESIGN—SESSION 31	COMPUTER GRAPHICS FILM SHOW—SESSION 29
	SMART POWER IC's FOR MILITARY AND COMMERCIAL APPLICATIONS—SESSION 32		
4:30 PM TO 6:30 PM	HIGH DEFINITION TELEVISION APPLICATIONS—SESSION 33	COMPUTER AIDED TEST AND DESIGN VERIFICATION: A REVIEW OF CURRENT TECHNIQUES AND APPLICATIONS—SESSION 34	
	BEYOND SURFACE MOUNT: SILICON INTERCONNECT SYSTEM PROVIDES HIGHER DENSITIES AND IMPROVED PERFORMANCE—SESSION 36	HIGH SPEED PROGRAMMABLE LOGIC EASES NEXT GENERATION SYSTEM DESIGN—SESSION 35	

systems. **Session 27** will describe several new devices, their development support tools, and typical applications.

New DSP ICs and their effect on telecommunications will be covered in **session 31**. The papers presented in that session will illustrate how today's standard DSP chips let you implement some sophisticated telecomm-oriented designs simply and how they can motivate entirely different design approaches.

Smart ICs will also receive some coverage in the Electro professional program. Speakers in **session 32**, for example, will discuss devices that accommodate a broad range of military, aerospace, and commercial applications. The five papers will stress application details and performance benefits, although novel technological developments will also be covered. The session will also present an overview of the different smart-power technologies in vogue today.

Addressing system considerations

This year's program also places a good deal of emphasis on system-level considerations. **Session 4**, for example, examines memory and memory-support innovations and developments. New architectures for both static and dynamic RAMs provide faster and more efficient system solutions for applications ranging from main storage to data buffering. The five papers in this session will also cover enhanced RAM architectures, which allow designers to employ RAMs in novel non-memory applications.

Cache memory and FIFO architectures for high-performance computer systems will get the spotlight in **session 12.** By decreasing data access time and increasing bus bandwidths, cache memories and high-speed FIFOs can increase the performance of computer systems. This session will discuss advances in the design and application of these system components and delve into their impact on system design.

Building on the system-level theme, **session 15** will address advances in CMOS structural system design. CMOS design is moving away from SSI/MSI hard macrocells towards structural system-level design. Designers can pick and choose from functional level libraries that contain soft LSI-level supercells and compiled data paths. Presentations in this session will highlight advanced automation techniques used to design, place, and route custom macro ICs.

Designers involved with Multibus II should have a special interest in **session 28**, which will provide a general understanding of Multibus II and the message-passing coprocessor (MPC). Those who attend will hear a wide-ranging discussion of the implications of using the MPC from various design perspectives—overall architecture, system performance, diagnostics, software, and I/O considerations.

Interest in number crunchers is high enough to merit 2-part session coverage. Part 1—**session 7**—will illustrate that LSI data-path elements are efficient, high-density devices for today's high-performance processing systems. Unlike fixed-instruction-set μPs, these data-path elements do not restrict the instruction repertoire, instruction syntax, or the architectural connectivity of systems. Newer architectures, such as array processors and direct high-level-language processors can now be economically implemented at a high level of integration.

Part 2—**session 11**—will detail more on this topic. Here, the papers will explore the use of LSI standard-logic building blocks for high-speed computation-intensive problems. The presentations will also address the use of programmable logic elements in data paths as contrasted with control paths.

Scanning the custom/semicustom-circuit area

Session 14 starts off the design-automation coverage. It will describe the benefits of using ASIC design centers and then focus on the tradeoffs between performing ASIC design in-house and using maufacturers, distributors, or independent third-party design centers.

Session 18 will explore analog design and analysis with CAE. The papers will illustrate how the use of a computer allows analog-circuit designers to analyze circuit performance without resorting to breadboarding. The speakers will also show how to automate analog-circuit design functions such as schematic entry, editing, circuit simulation, parameter entry, and statistical analysis.

For more on the design-automation theme, you can attend **session 34** for details on current techniques and applications of computer-aided test and design verification. The five papers in this session will review the implications of design verification and analysis in regard to gate-array, cell-based, and silicon-compiler-based ASICs.

What's happening on the factory floor

"American Manufacturing: Our Competitive Edge" is the topic of **session 13.** Heavy foreign competition has prompted a response by the US, and this session will highlight the country's successes in factory automation.

In **session 17**, you can learn about the offshore

A variety of minitutorials will cover a broad range of topics.

opportunities that can help companies reduce costs and expand into international markets. The four papers will explain how a good international business strategy can help most companies substantially reduce their production costs without sacrificing quality.

The military may also have an impact on manufacturing productivity: The DoD's Ada programming language can be appropriate for commercial applications in factory control and robotics, for example. And in **session 6**, you'll learn about the variety of software development tools and run-time targets that are available today.

Designing in the real world

Today, most design engineers realize that there's more to their jobs than what's just listed on the job description—social and ethical considerations cannot be ignored. Both of these sensitive areas will be addressed at Electro. **Session 1** will take a look at the social implications of artificial intelligence—specifically, the concept of artificial-intelligence systems that could support or supplant human thinking.

The panelists in **session 5** will explore ways that conscientious engineers can be less vulnerable to retaliation when they differ with managers on ethical grounds. The presentations will discuss such topics as providing engineers with information on the records of prospective employers; professional society investigations; public reports on specific cases; and the role of the law.

Minitutorials will cover a lot of ground

Seven sessions have been designated as minitutorials, and they cover a wide range of topics. **Session 25** will introduce attendees to computer graphics. The meeting will present the basic principles and techniques of interactive graphics using 35-mm slides. It will focus on techniques necessary for generating realistic images, such as shading and texturing.

Session 29 is a film show that will present some of the computer-generated films that were shown at recent ACM/SIGGRAPH computer-graphics conferences. The

films cover diverse topics ranging from research to artistic and commercial applications. They illustrate techniques of 2- and 3-dimensional image creation, animation, line drawings, filled and solid images, shading and lighting effects, and combined computer and optical effects.

Session 20 highlights current directions in lightwave components and systems. Although fiber-optic systems are established parts of telecommunication networks, new technologies are moving quickly from the laboratory to the field. This minitutorial will explore lightwave devices and systems, with emphasis on long-haul and local-area networks.

Building the optical theme, **session 16** will focus on the potential of fiber-optic sensors to change many areas of sensing by offering such characteristics as resistance to EMI, superior environmental performance, and electrical isolation. This minitutorial will also discuss the guided-wave optical components that are the building blocks of fiber-optic sensor technology.

You can attend a minitutorial **(Session 26)** devoted to new applications for electro-optical components. High-speed, high-frequency electro-optical devices and circuits are essential for the wide-bandwidth communication links, high power systems, and radar applications for the future. This session will include a comprehensive review of recent advances in the control of electrical energy using electro-optical components.

Finally, a minitutorial **(Session 22)** devoted to optimizing semicustom design will explain how designers can greatly improve their chances of getting a workable, functional, semicustom chip the first time. The discussions will show how to use a CAE workstation to provide a foundry with fully simulated design that will be translated into the net-list format of the foundry.

EDN

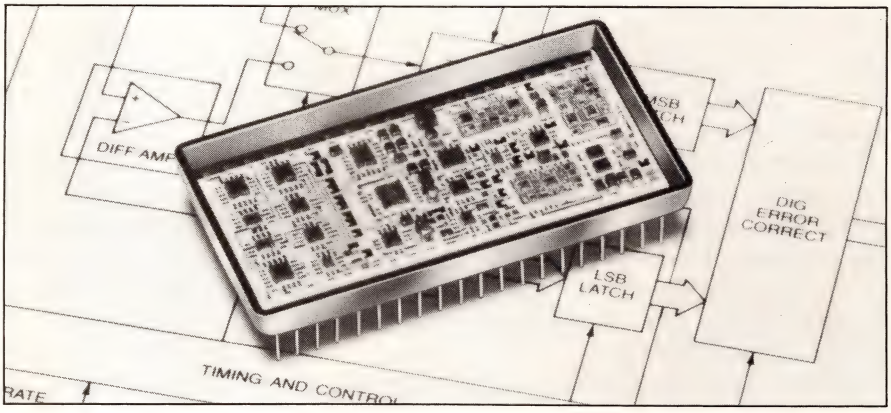
Article Interest Quotient (Circle One)
High 497 Medium 498 Low 499

Electro/87 Products

Hybrid 12-bit A/D converter includes track/hold amplifier

The ADC-00300 combines an A/D converter with a track/hold amplifier in one 40-pin triple DIP. It delivers 12-bit resolution at 500-nsec (2-MHz) update rates. The ADC-00300 also contains data registers, 3-state output buffers, and timing circuits. The converter's design combines a custom, monolithic high-speed DAC with a fast-settling discrete op amp.

The output registers and 3-state buffers let you easily interface the ADC-00300 to most CPUs. The converter accommodates nine bipolar and unipolar (user-selectable) analog input ranges: ±2.5V, ±5V, ±10V, 0 to 5V, 0 to 10V, 0 to 20V, 0 to −5V, 0 to −10V, and 0 to −20V. Because all the timing is self-contained, the unit requires only an Encode command to start its conversion cycle.



The part's S/N ratio and harmonics are 65 and 68 dB min, respectively. Its maximum linearity error is 0.05% of full-scale range, and its operating-temperature range is −55 to +125°C. Parts screened to MIL-STD-883 are also available. From $750. Delivery, eight to 12 weeks ARO.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716. Phone (516) 567-5600. TWX 510-228-7324. Booth Nos 2124 and 2126.

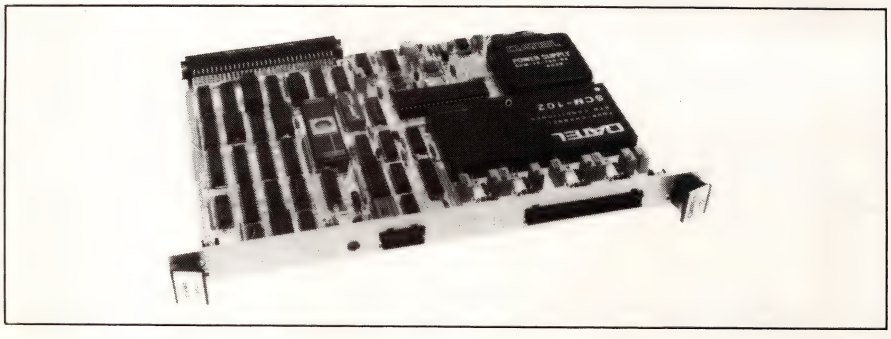
Circle No 530

Intelligent analog-input board eases VME Bus-system RTD measurements

The DVME-602R is specifically designed for resistance-temperature-detector (RTD) measurements in VME Bus-based systems. You can connect RTD transducers directly to the board's four input channels; a 0.4-mA internal excitation current eliminates lead-resistance errors.

The board filters and amplifies the RTD signals and then converts them to digital data by using an integrating A/D converter. An onboard μP linearizes and scales the digitized values and transmits a binary quantity representing a temperature (in user-selectable units—°C or °F) to the VME Bus host computer.

At power-up, onboard diagnostics test each channel for open RTD or over- or under-range conditions.



The diagnostic program also detects any error status of the onboard CPU or memory hardware.

The -602R operates in either sequential- or random-channel scan modes. In sequential mode, the board's CPU automatically loads the latest available data on all four channels to the data register in sequence. In random mode, the CPU continuously loads the register with the latest data of a selected channel.

The DVME-602R offers a choice of four conversion rates—15 or 30 conversions/sec at 60 Hz or 12.5 or 25 conversions/sec at 50 Hz. $1419.

GE/Datel, 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TLX 951340. Booth Nos 1524, 1526, and 1528.

Circle No 532

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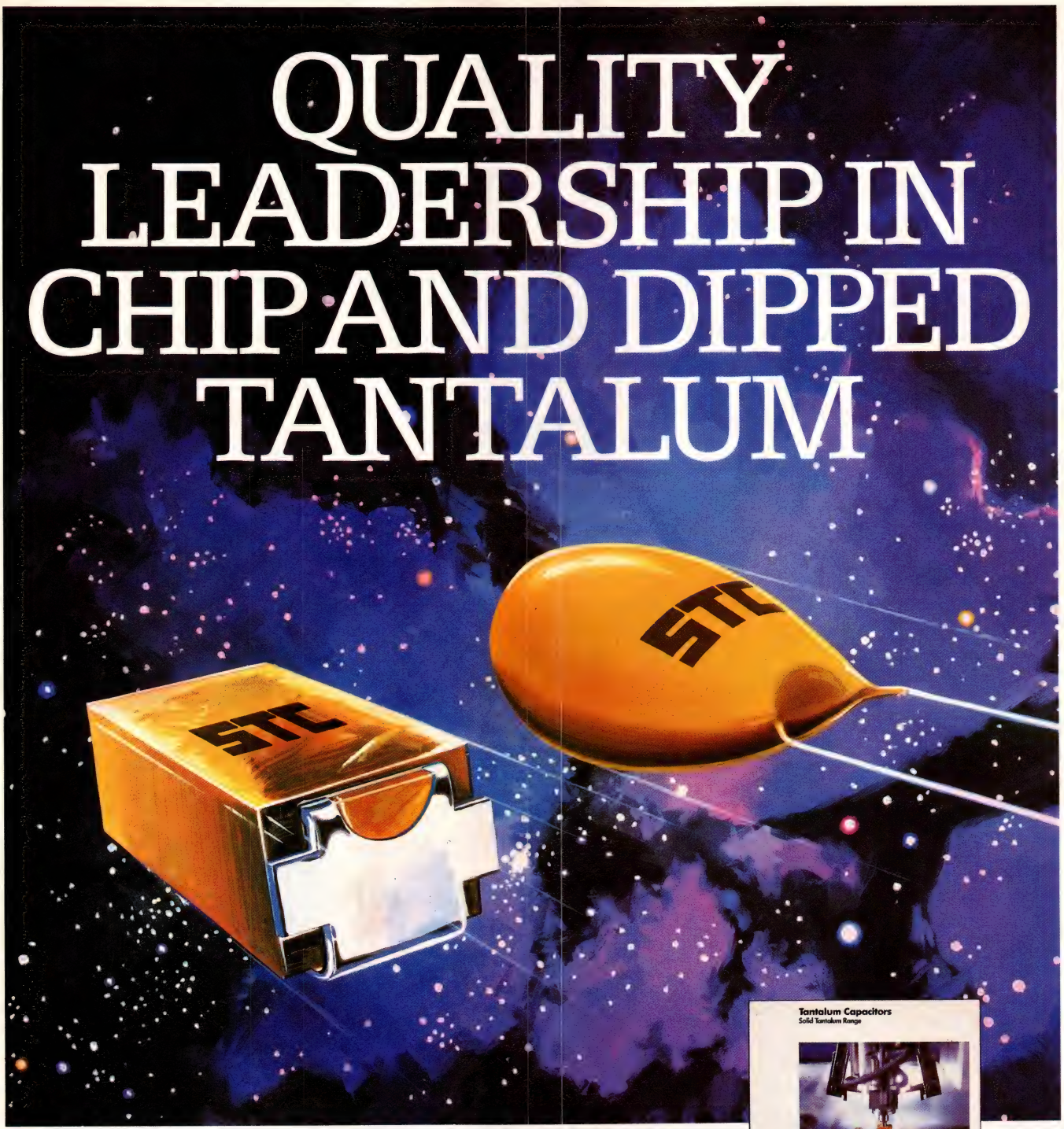

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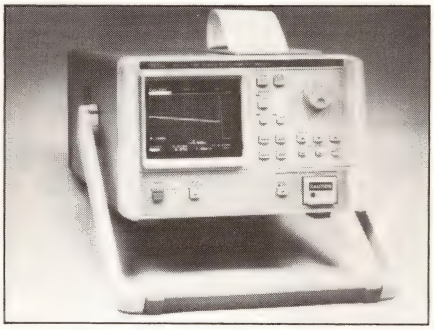
CIRCLE NO 122

Electro/87 Products

Optical time-domain reflectometer offers short-distance capability

Designed for subscriber-loop applications, the MW920A optical time-domain reflectometer can locate and evaluate closely situated splices with precision. Special keys let you quickly select and set measurement conditions, such as attenuation and averaging time.

The instrument's 3-nsec pulse width virtually eliminates dead-zone problems, the manufacturer claims. You can readily locate fiber faults to within 3m max over distances ranging to 40 km. Plug-in optical heads are available for either 0.85- or 1.3-μm wavelength, multimode fiber applications.



The portable MW920A weighs 26 lbs. It features a built-in printer that provides a hard copy of its 5.5-in. CRT display, and it provides a standard GPIB interface for remote operation. Its integral memory allows you to store and recall as many as five sets of displayed data, including measurement conditions and fiber traces.

The meter is suitable for both lab and field use. Field applications for the unit include characterizing fiber in LANs, subscriber loops, and military systems. Lab uses for the meter include the automatic testing of jumpers, pigtails, connectors, and splices. $7000 for the mainframe. The MH951A (0.85 μm) and MH952A (1.3 μm) plug-ins cost $10,200 and $13,000, respectively.

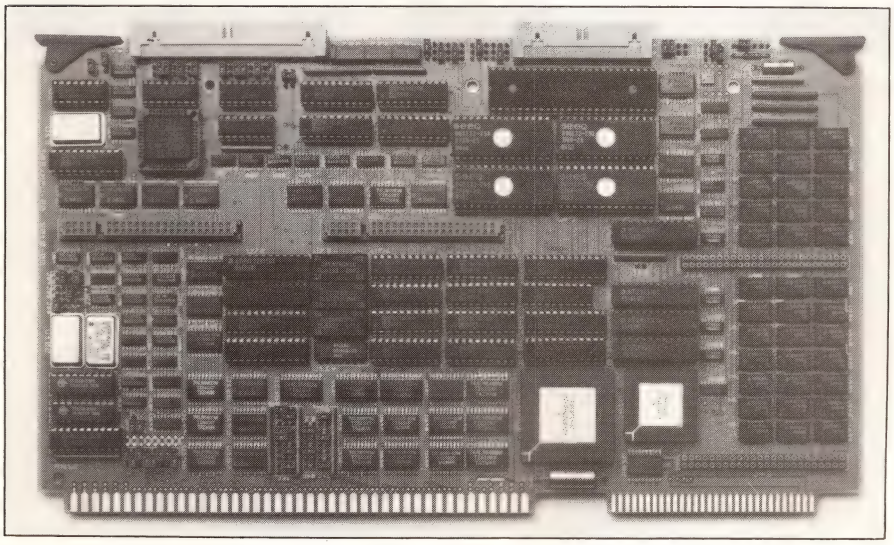
Anritsu America Inc, 15 Thornton Rd, Oakland, NJ 07436. Phone (201) 337-1111. TLX 642141. Booth Nos 2481 and 2483.

Circle No 533

68020-based Multibus board-level computer eases upgrade to 32-bit operation

The MPU-20 is a 68020-based single-board computer that runs at either 12.5 or 16.7 MHz. You have the option of coupling the board with a 68881 floating-point coprocessor that offloads number-crunching duty from the main processor.

The board includes 1M byte of parity-protected dynamic RAM implemented in 256k-bit RAM chips. By replacing the 256k-bit RAMs with 1M-bit dynamic RAMs, you can increase the storage to 4M bytes. The MPU-20 has a 32-bit-wide data path to RAM, and you can use the dynamic RAMs to implement no-wait-state operation.

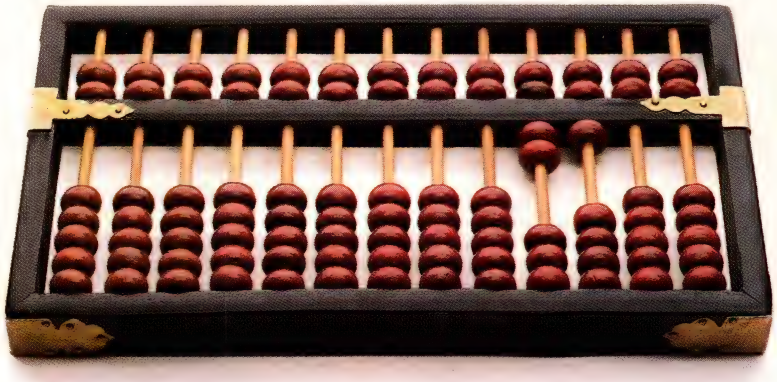


Serial and parallel I/O are provided by two multiprotocol, full-duplex serial ports and a 24-bit 68230 bidirectional parallel port and timer. The serial ports support asynchronous, bit-synchronous, and byte-synchronous protocols. The boards' maximum baud rate for synchronous operation is 800k bps.

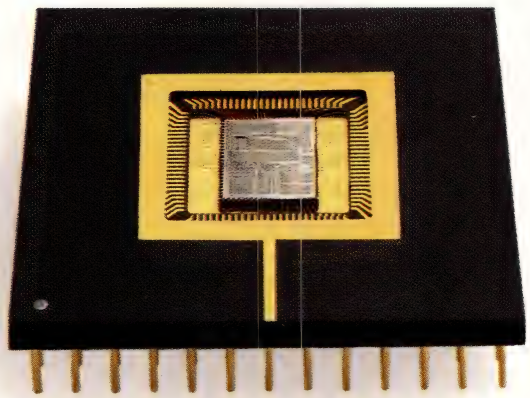
The MPU-20 has four 28-pin EPROM sockets: Two are dedicated to EPROM; the other two can hold EPROM, static RAM, or EEPROM. Two 16-bit iSBX connectors allow for I/O expansion. A programmable fault timer lets you protect the system from malfunctions by halting the processor when it has not been written to within a specific time. $1995 (100).

SBE Inc, 2400 Bisso Lane, Concord, CA 94520. Phone (415) 680-7722. TWX 910-366-2116. Booth Nos 517 and 519.

Circle No 531



DIGITAL BY ANALOGY.



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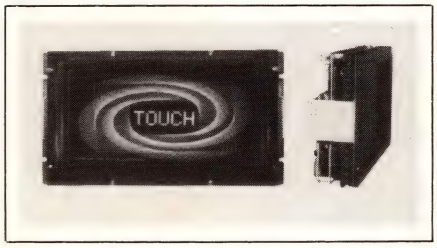
ANALOG DEVICES

Electro/87 Products



DISPLAY MODULE

The M3EL512X256 is an infrared-type touchscreen display module. Designed specifically for 512×256-dot electroluminescent displays, it features a sealed bezel and filter assembly and an internal interface for the company's graphics and text controller.

The module includes expanded touchscreen software features, such as pop-up menus, enter, exit, and track/touch modes, smooth scroll, and a command set that includes 68 graphics primitives. Host interfaces are available in either high-speed serial and/or parallel configurations. The module measures 10.278×5.078×2.5 in. and operates with 5 and 12V dc supplies. $3445.

Digital Electronics Corp, 26142 Eden Landing Rd, Hayward, CA 94545. Phone (415) 786-0520. TLX 172073. Booth Nos 2305 and 2307.

Circle No 536

SIGNAL SOURCE

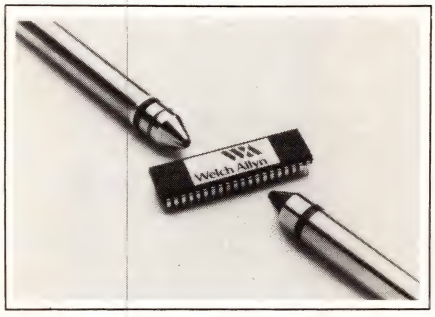
Model 6201A is three programmable instruments in one—a pulse generator, a function generator, and a reciprocal 20-MHz counter. The fully programmable unit features μP control of all functions and provides sine, square, and triangular waves with variable amplitude, symmetry, and offset over a range of 20 mHz to 20 MHz. Its output amplitude ranges from 1 mV to 30V p-p, or 15V into 50Ω.

The 6201A includes a nonvolatile memory that retains the last setup and permits you to recall 10 complete preprogrammed test setups by using the front-panel controls or the IEEE-488 interface bus. Built-in self-test routines automatically check instrument function and the bus interface at power-up.

You can gate output waveforms with an external signal or a front-panel switch. The built-in reciprocal counter measures the frequency of the output waveform and phase-locks the output to an internal crystal. The instrument requires 60W max and operates over 0 to 45°C. A rack-mount adapter (for 5¼-in. panels) is optional. $3375 for the generator, $175 for the adapter.

Ballantine Laboratories Inc, Box 97, Boonton, NJ 07005. Phone (800) 323-3234; in NJ, (201) 335-0900. Booth No 1543.

Circle No 534



DECODER CHIP

Working with a stainless-steel digital scanner, the CMOS LTS-3C single-chip decoder adds bar-code-reading capability to new or existing data-input products. It requires no external RAM and draws only 5 mA from a 5V supply. The chip offers a choice of interfaces. It has an 8-bit port that's configured for parallel data communication. Additional serial in and out lines and RTS/CTS (request to send/clear to send) handshake lines are also available. The chip can transmit serial data at 1200 or 9600 baud.

The LTS-3C decodes five symbologies: Codabar, 3-of-9 (including full ASCII), interleaved 2-of-5, UPC, and EAN/JAN. The chip can scan all the codes (except UPC and EAN/JAN with addenda) in a bidirectional manner at 3 to 30 ips. It decodes the addenda left to right only. Chip/sensor combination, $237; chip alone, $95.

Welch Allyn Inc, Industrial Products Div, Skaneateles Falls, NY 13153. Phone (315) 685-8945. TLX 325435. Booth Nos 2065 and 2067.

Circle No 535

DC/DC CONVERTERS

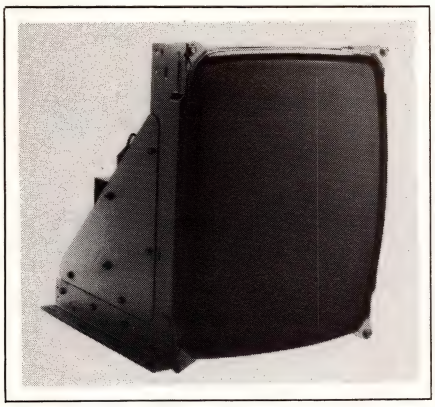
The SA and SB Series of dc/dc converters employ state-of-the-art hybrid technology and a 220-kHz switching frequency to achieve 10W/in^3 power densities. The pc-board-mountable lines include single- and multiple-output models that operate from a nominal input of 48V dc.

The SA and SB converters are housed in 6-sided metal cases measuring 2×2×0.43 and 3×3×0.43 in., respectively. The units feature 500V dc input-to-output isolation, minimum efficiency of 75%, and an MTBF of more than two million hours. The converters are convection-cooled over an ambient operating range of 0 to 60°C. Any output can provide as much as 50% of the total output power. $69 (OEM qty). Delivery, stock to 10 weeks ARO.

International Power Sources Inc, 10 Cochituate St, Natick, MA 01760. Phone (617) 651-1818. TWX 510-100-3630. Booth No 564.

Circle No 538

Electro/87 Products



TOUCH DISPLAYS

The K7000 displays are completely integrated color units that provide graphics superimposed over video, high-quality analog-RGB, NTSC, and audio signals. They use a proprietary, high-resolution, single-LED touchscreen system.

The displays include both standard CRTs and the popular square, flat-faced tubes, and are available in 13-, 15-, 18-, and 19-in. sizes. Their resolution ranges from TV grade (320×240 pixels) to fine pitch (640×240 pixels) in a variety of horizontal scan frequencies.

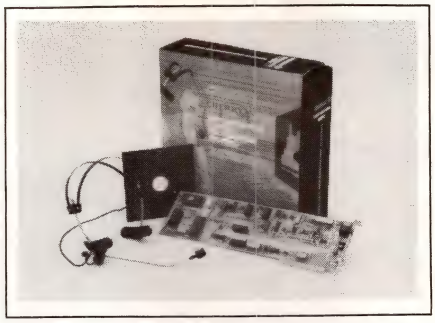
The Cyclops touchscreen intelligent controller is built into the display; it transmits X-Y data over the RS-232C line. The optical system's inherent stability minimizes the need for field calibrations. Custom sizes and configurations are available upon request. Integrated samples are available in four to six weeks ARO. The 13- and 19-in. sizes cost $700 and $800, respectively.

Wells-Gardner Electronics Corp, 2701 N Kildare Ave, Chicago, IL 60639. Phone (312) 252-8220. TLX 253286. Booth No 935.

Circle No 537

SPEECH SYSTEM

Voicescribe-1000 is a word-pattern-recognition system that can recognize 1000 words or phrases with 99.3% measured accuracy, according to the manufacturer. It allows you to enter voice data into an IBM PC, PC/XT, PC/AT, or compatible machine. It includes software overlays for popular applications—spreadsheet, word processing, database, etc.

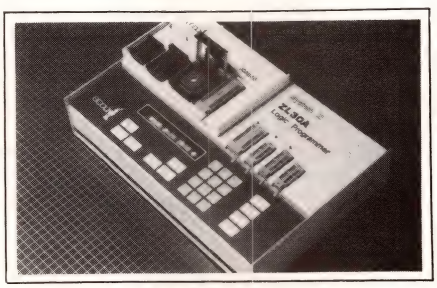


The system is simple to install, and it can be operational in less than one hour. You can add and edit user vocabulary during an application without exiting or ending an operation. You can also combine voice patterns, allowing multiple speakers to use the system, and providing speaker-independent operation for smaller vocabularies. The compiler function allows you to create custom overlays.

The hardware requirements include an open expansion slot in the PC, a hard-disk drive, and 512k bytes of RAM. $1195 for the total system (software diskettes, expansion card, headset/microphone, and tutorial manual).

Cherry Electrical Products Corp, 3600 Sunset Ave, Waukegan, IL 60087. Phone (312) 360-3500. TWX 910-235-1572. Booth Nos 2359, 2361, 2363, and 2365.

Circle No 539

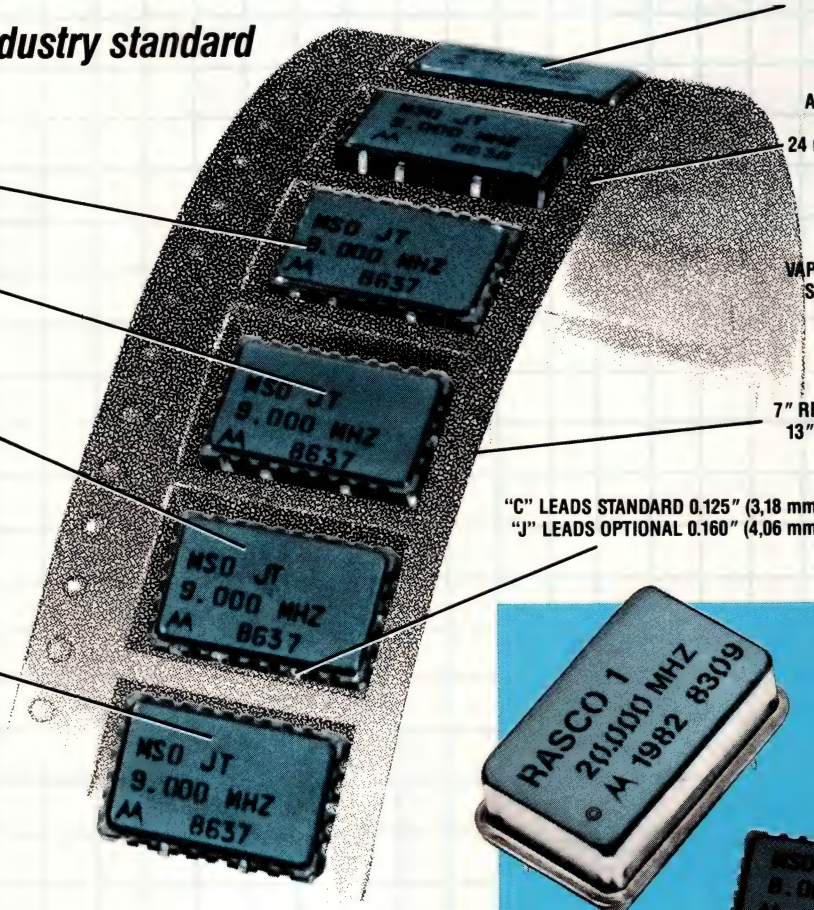


PROGRAMMER

The ZL30A logic programmer offers an editing facility. The mainframe supports a range of programmable logic devices (PLDs), including PALs, IFLs, EPLDs, and GALs in 20-, 24-, and 28-pin packages. You

Surface Mount Oscillators from Motorola

. . . the new industry standard



Motorola's RASCO oscillator and the New Surface Mountable MSO

Ideal for Automatic Placement — Motorola's MSO Series oscillators are designed for placement with state-of-the-art pick-and-place automated assembly equipment and are available with either tape & reel or anti-static tube packaging. The MSO oscillator is vapor phase/wave solder reflowable.

Product Features — Available over a frequency range of 1.5 MHz to 35 MHz, with stability of ±0.01% over the temperature range of 0°C to +70°C. Symmetry is 40/60% standard, with 45/55% optional. Compatible with either CMOS or TTL logic.

5,000g Shock Rating — Uses AT strip crystals with mechanical shock performance greatly superior to that of conventional crystals — made by a proprietary process that avoids the edge faults, fractures, and weaknesses inherent to conventional processes.

A New Quality Standard — Even when compared to the industry standard RASCO clock oscillators, MSO Series oscillators have 59% fewer processing operations, are assembled in a class 100 clean room with completely automatic processing, have 37% fewer components and 58% fewer interconnects.

For additional information or for samples, contact Motorola Inc., Components Division, Data Clock Sales, 2553 N. Edgington St., Franklin Park, IL 60131, or call (312) 451-1000, Ext. 4835, FAX: (312) 451-7585 TWX: (910) 255-4619 TELEX: 499-0104.

See Us at Electro Booth No. 1648

MOTOROLA

Motorola Components Division is a broad-based supplier of quality components for the electronics OEM. For more information about specific product lines, contact:
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Piezo-Ceramic Speakers, Filters, Transducers, Displays / Albuquerque, NM (505) 822-8801 • **Hybrid Circuits** / Ft. Lauderdale, FL (305) 475-5000
NiCd Batteries / Ft. Lauderdale, FL (305) 475-5000 • **Printed Circuit Boards** / Schaumburg, IL (312) 576-8468

can add expansion modules that fit easily into the top-panel connector and accommodate 40-pin DIPs and surface-mount LCCs and PLCCs. You can enter fuse maps via the keypad. All the programmer's functions work interactively with an integral display that shows the sequence of events, programming and test patterns, and visual confirmation of the operations undertaken. The mainframe supplies an IEEE-488, an RS-232C, and a parallel-port handler interface. $3495.

Stag Microsystems Inc, 1600 Wyatt Dr, Santa Clara, CA 95054. Phone (408) 988-1118. TWX 910-339-9607. Booth Nos 2478 and 2480.

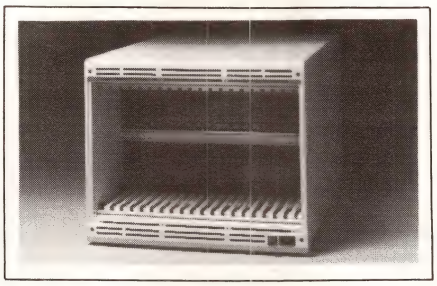
Circle No 540

SIGNAL GENERATOR

Model 2022A specs an output flatness of ±0.5 dB over 10 kHz to 1000 MHz. You can set the RF output in 0.1-dB steps from −127 dBm to +6 dBm. Offsets of ±2 dB help compensate for external losses. FM distortion at 1 kHz is less than 0.5% for deviations to 25 kHz and less than 2% at maximum deviation for any carrier frequency greater than 250 kHz. When you use an external source for modulation, the generator's AM frequency response at 80% depth equals ±0.5 dB from 50 Hz to 15 kHz. Distortion at a 1-kHz modulation frequency is less than 3% for depths of as much as 80% and less than 5% for depths of as much as 95%. $4395.

Marconi Instruments, 3 Pearl Ct, Allendale, NJ 07401. Phone (201) 934-9050. Booth No 1854.

Circle No 542



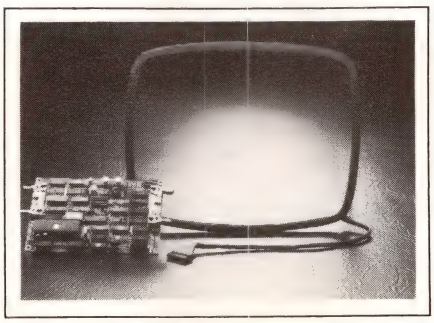
CHASSIS

The Maxchassis has a modular design that accommodates as many as two 20-slot VME Bus or Multibus card cages, three 52-cfm fans, two 750W power supplies with integral fans, and assorted 5¼-in. data-storage peripherals.

The vendor can supply hardware, including track slides and handles, that lets you use the Maxchassis as a table-top or rack-mount product. The package is designed to meet UL, CGA, TUV (VDE equivalent), and FCC specifications. The manufacturer provides a 3-year limited warranty on the entire package. A typical assembled package including the Maxchassis; a 6U-high, 20-slot card cage with a backplane and three fans; a 600W power supply; and required wiring costs $3200.

Zero Corp, Scanbe Div, 3445 Fletcher Ave, El Monte, CA 91731. Phone (818) 579-2300. TWX 910-587-3437. Booth Nos 850 and 852.

Circle No 543



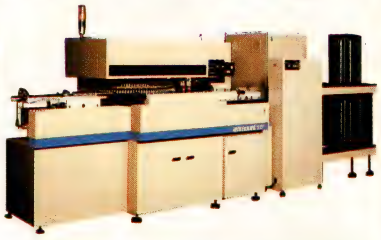
TOUCH PANEL

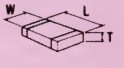
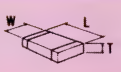
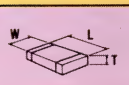
TekTouch consists of a thin, continuous, transparent film deposited on a glass panel. The touch panel determines the touched position by measuring changes to a small ac signal applied to the panel. Its integral electronics computes and transmits

In Surface Mountable Components, TDK Quality Is More Than Skin Deep.

As boards are getting thinner, TDK is helping that diet succeed by providing a variety of extra-slim surface mountable components. Nourished by TDK's expertise in ferrite and ceramic materials, these miniaturized components feed on TDK—developed multi-layerization and multi-functionalism.

How do we know the exact needs of high-quality automated board production? Well, a fair share of the world's automatic mounting equipment —the Avimount series—comes from TDK.



Product name		Type	Shape	Dimensions L (mm)	W (mm)	T (mm)	Electrical Characteristics
Multilayer Ceramic Chip Capacitor		C1508		1.5	0.8	1.0	C: 0.5~470pF, 100~22,000pF
		C2012		2.0	1.25	0.6 0.85 1.25	C: 0.5~1,800pF C: 470~100,000pF
		C3216		3.2	1.6	0.6 0.85 1.1	C: 0.5~270pF C: 470~220,000pF
		C3225		3.2	2.5	< 1.9	C: 750~8,200pF, 56,000~470,000pF
		C4532		4.5	3.2	< 1.9	C: 2,400~18,000pF, 180,000pF~1μF
		C5650		5.6	5.0	< 1.9	C: 5,100~33,000pF, 270,000pF~1.5μF
Multilayer Ceramic Chip Capacitor (High Frequency, Low Loss)		FC1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FC2828		2.8	2.8	2.8	C: 0.5~1,000pF, 470~22,000pF
		FR1414		1.4	1.4	1.6	C: 0.5~100pF, 150~3,300pF
		FR2828		2.8	2.8	2.8	C: 0.5~1,000pF, 470~22,000pF
Leadless Inductor (Wound Chip Inductor)		NL322522		3.2	2.5	2.2	L: 0.01~220μH
		NL453232		4.5	3.2	3.2	L: 1.0~1,000μH
		NL565050		5.6	5.0	5.0	L: 1,200~10,000μH
		NLF453232		4.5	3.2	3.2	L: 1.0~1,000μH (Shielded Inductor)
Multilayer Chip Inductor		MLF3216		3.2	1.6	0.6 1.1	L:0.047~220μH
		MLF3225		3.2	2.5	1.1 1.8 2.5	
Multilayer Chip Transformer		MTT4532		4.5	3.2	2.8 max.	L: 10~200μH
Multilayer Chip IFT		MIA4532		4.5	3.2	2.8	F:455, 459, 464kHz
		MIF4532		4.5	3.2	2.2	F: 10.7MHz
Multilayer Chip LC Trap		MXT4532		4.5	3.2	2.8 max.	F: fo ±2%
Multilayer Chip LC Filter	HPF (Tuner)	MXF4532H		4.5	3.2	2.8 max.	Electrical characteristics are representative, please specify value when ordering.
	BPF (FM radio)	MXF4532B		4.5	3.2	2.8 max.	
	BPF (VCR)	MXB5050B		5.0	5.0	2.8 max.	
	LPF (VCR)	MXB5050L		5.0	5.0	2.8 max.	
	Equalizer (VCR)	MXB5050E		5.0	5.0	2.8 max.	
	Delay Line (VCR)	MXB5050D		5.0	5.0	2.8 max.	
Multilayer Chip Capacitor Network		MCN7575		7.5	7.5	0.9	C: 1~1,000pF (TC:CH) (10 capacitors) C:10~1,000pF (TC:SL) (10 capacitors)
Ferrite Chip Beads		CB201209		2.0	1,25	0.9	Zo: 7, 10, 11Ω
		CB321611		3.2	1.6	1.1	Zo: 19, 26, 31Ω
		CB322513		3.2	2.5	1.3	Zo: 31, 52, 60Ω
		CB453215		4.5	3.2	1.5	Zo: 70, 120, 125Ω
SM Active Delay Line		FDL		12.0	9.5	5.6	Delay time: 20~250 nsec.
SM Transformer/ Inductor		EE5		7.4	5.3	4.75	Electrical characteristics are representative, please specify value when ordering.
		ER9.5		11.5	9.5	6.3	
		ER11		12.5	11.0	6.3	
		T2		7.0	5.0	2.2	
SMD Step-up Inductor (Piezoelectric Buzzer)		OL3.3×1.6		5.6	5.3	1.6	Inductance values are representative, please specify value when ordering.
		OL3.3×2.1		5.6	3.3	2.1	

See our Chip Components and other fine products at Electro/87 April 7-9, Jacob K. Javits Convention Center New York. TDK Booth No. 2672.

TDK®

Electro/87

TDK CORPORATION OF AMERICA HEAD OFFICE 4711 West Golf Road, Skokie, IL 60076, U.S.A. Phone: (312) 679-8200 CHICAGO REGIONAL OFFICE Phone: (312) 679-8200 LOS ANGELES REGIONAL OFFICE Phone: (213) 539-6631 INDIANAPOLIS REGIONAL OFFICE Phone: (317) 872-0370 NEW YORK REGIONAL OFFICE Phone: (516) 625-0100 SAN FRANCISCO DISTRICT OFFICE Phone: (408) 435-8565 DETROIT DISTRICT OFFICE Phone: (313) 353-9393 HUNTSVILLE DISTRICT OFFICE Phone: (205) 539-4551 GREENSBORO DISTRICT OFFICE Phone: (919) 292-0012 DALLAS DISTRICT OFFICE Phone: (214) 506-9800 NEW JERSEY DISTRICT OFFICE Phone: (201) 736-0023 **TDK CORPORATION.** TOKYO, JAPAN.

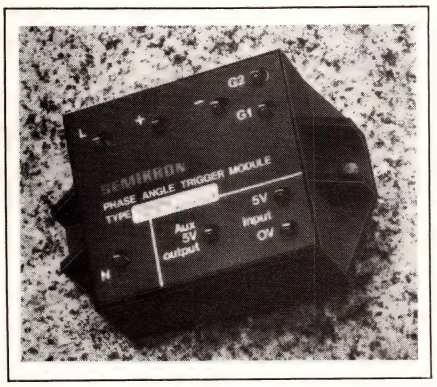
CIRCLE NO 86

touch locations to the host system. Soft keys allow you to define as many as 256 points per axis. TekTouch links to the host computer through either RS-232C or parallel interfaces.

The panel's minimum parallax error and 85% transmissivity provide optical clarity. TekTouch mounts under your present CRT/monitor bezel and requires only 0.2-in. clearance. The controller circuitry fits onto a 4×6-in. board that mounts directly inside the monitor. A harness connects the panel and controller board. Evaluation kit, $800. Delivery, eight weeks ARO.

Tektronix Inc, Display Devices Operation, Box 500, Beaverton, OR 97077. Phone (503) 627-6868. TLX 151754. Booth Nos 1635, 1636, 1637, and 1638.

Circle No 541



TRIGGER MODULES

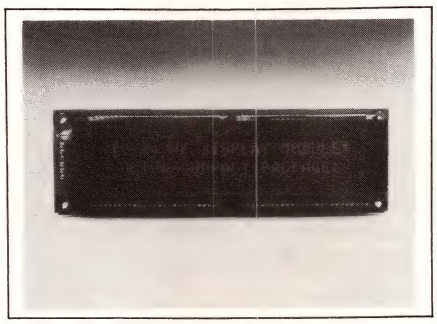
These encapsulated thyristor-type modules eliminate the need to design trigger circuitry. TC101 Series units are suitable for zero-voltage or instantaneous triggering; PCT Series devices accommodate phase-control applications.

TC101 Series modules provide instantaneous triggering and are converted to zero-voltage switching by a wire link. You can drive their fully isolated logic inputs from TTL or CMOS circuits.

PCT Series phase-angle trigger modules provide optimum levels of isolated gate drive for thyristor modules or discrete SCRs, the manufacturer claims. The modules generate a gate-trigger pulse with variable delay that is proportional to a 0 to 5V input signal. Two versions are available—one for triggering an ac controller, and the other for triggering a half-wave-controlled, single-phase bridge. The TC101-460, a zero-crossing module for 460V rms lines, costs $26 (100). Delivery, stock to six weeks ARO.

Semikron Inc, Box 66, Hudson, NH 03051. Phone (603) 883-8102. TLX 6711011. Booth No 2608.

Circle No 544



VF DISPLAYS

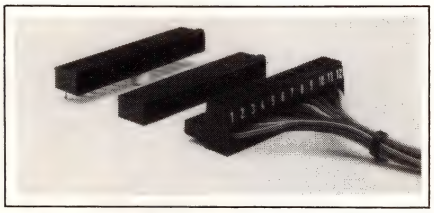
The 3601-48-048 is a 2-line×24-character intelligent vacuum-fluorescent-display module. The module, which measures 5.3×1.6×1.36 in. (excluding the swivel-mounting brackets), employs surface-mount technology. Its 5×7-dot, blue-green characters are 4.5 mm high. The module offers three software-controlled brightness levels ranging from 50 to 380 fL.

The module operates from one 5V supply. An onboard μP controls all the display functions and easily interfaces to an 8-bit parallel TTL bus. A 1200-baud serial interface is also standard; it has a jumper that allows you to select either TTL- or RS-232C-level inputs. The module displays the full 96-character ASCII set, as well as additional European and scientific characters. $163 (100). Delivery, four to six weeks ARO.

IEE Inc, Industrial Products Div, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311. TLX 4720556. Booth Nos 2349, 2350, 2351, 2352, 2353, and 2354.

Circle No 545

Electro/87 Products



CARD CONNECTORS

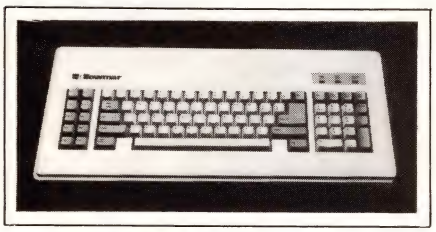
Series 8113B polarized plug and socket connectors are rated to VDE 0110 grade B and meet UL 94V-0 flammability requirements. They mount flush with the pc board, preventing stress on the pin solder joints. Each plug connector is molded with a locking tab that protects it from vibration and shock.

The units feature 5-mm pin spacings, and they're available in either horizontal or vertical configurations in 2- to 24-position versions. The connectors are rated for 300V at 10A or 250V at 15A, and they can accommodate wire sizes as great as 12 AWG.

The contact springs and solder pins are tin-plated bronze. The pressure clamps and screw assemblies are nickel-plated brass. The captive terminal screws prevent self-loosening by securing themselves when tightened. The connectors feature a braking action, which protects the wire from any pressure caused by overtightening. $5.16 (1000) for a 12-position version.

Electrovert Inc, 466 Main St, New Rochelle, NY 10801. Phone (914) 633-0222. Booth Nos 2339, 2341, and 2343.

Circle No 546



KEYBOARD

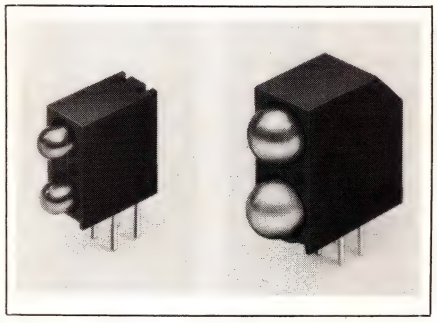
Opti-Key, a full-travel DIN keyboard, detects key movement by using infrared technology based on a patented matrix of emitters and detectors. The keyboard obtains the multiplexed key-location data by pulsing the emitters and scanning the detectors.

Compared with other optoelectronic techniques, this sensing scheme reduces both power consumption and component count. Opti-Key offers true N-key rollover, 100-million-cycle key life, and self-diagnostic status analysis.

The standard model features 84 keys, ASCII-coded outputs, and an IBM PC or RS-232C interface. The key arrays, coded outputs, and interfaces can be customized to your specifications. The keys travel 0.13 in. typ and require 3 oz typ operating force. The standard keyboard, with a PC interface, operates from 5V. $150 (100).

Bowmar Instrument Corp, Data Entry Div, 4640 126th Ave N, Clearwater, FL 33520. Phone (813) 576-2525. TWX 810-863-0375. Booth No 868.

Circle No 548



LED INDICATORS

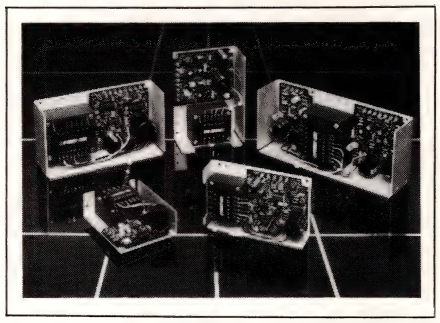
Series 553 (size T-1) and 552 (size T-1¾) bilevel LED indicators suit high-density circuit-board applications. When you stack the two LEDs vertically instead of horizontally, the devices require 50% less board space.

The indicators are resistant to shock and vibration and are housed in a black case. Optional versions include standard-efficiency, high-efficiency, super-bright, and super-efficiency LEDs that produce full light output with only 2 mA of forward current.

Integral resistor lamps, which offer 5 and 12V operation, are also available. All versions are available in red, green, or yellow. The vendor also offers a bicolor model that contains red and green color chips. $0.62 (1000).

Dialight Corp, 203 Harrison Pl, Brooklyn, NY 11237. Phone (718) 497-7600. Booth Nos 1735, 1737, 1739, and 1741.

Circle No 549



LINEAR SUPPLIES

The International Series open-frame linear power supplies operate from a wide range of input-power sources. The line consists of 78 single- and multiple-output models with outputs ranging from 2 to 250V dc. The units come in 17 case sizes and have output-power ratings ranging to 280W.

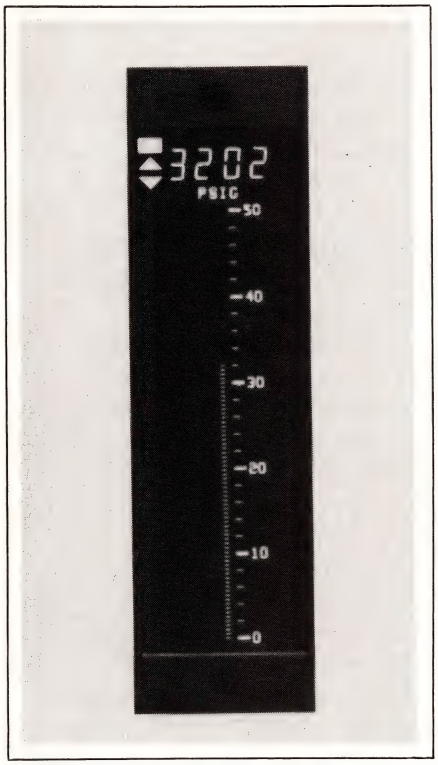
Every model complies with UL, CSA, IEC, VDE, BPO, ECMA, and CEE regulations, the vendor claims. Each unit accommodates (via jumper selection) the ac input ranges needed for worldwide operation: 100, 120, 220, 230, and 240V ac at 47 to 63 Hz.

Typical specs for the supplies include ±0.05% line regulation (10% change) and ±0.05% load regulation (0% change). Their efficiency ranges from 45 to 60% typ, and their output ripple is 5V max. Automatic current limiting, short-circuit protection, and foldback overload protection is standard on all models. From $32.95.

Power-One DC Power Supplies, 740 Calle Plano, Camarillo, CA 93010. Phone (805) 987-8741. TWX 910-336-1297. Booth Nos 1846 and 1848.

Circle No 551

Electro/87 Products



BAR-GRAPH DISPLAY

Models BA101 and BB101 are μP-based displays. They can be individually or gang mounted on 1.74-in. centers for high-density panel applications. The BB101 is a commercial-grade unit that meets or exceeds the specifications of ANSI C39.1; the BA101 is qualified as a Class 1E instrument for nuclear applications. Both models consist of 101 LED segments for dynamic trend information and an optional 4-digit readout for enhanced accuracy and resolution of the process variable. You can scale and calibrate the readout to display absolute engineering units.

Three set points with Form C relay contacts are available for on/off process control. The set points can be continuously displayed on command. The relays are normally energized; in case of a problem, they de-energize. The relays are rated for 2A at 250V ac and 3A at 30V dc. $229 to $415 (100).

Dixson Inc, Instruments Div, Box 1449, Grand Junction, CO 81502. Phone (303) 242-8863. TWX 910-929-6991. Booth No 2284.

Circle No 547

D/A CONVERTERS

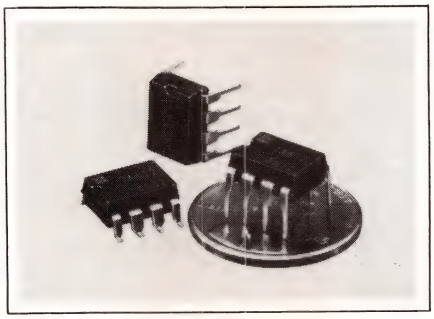
These 8-bit, R/2R-ladder D/A converters run at video speeds. Two versions are available: The CA3338 has integral and differential linearity errors of 1 and ¾ LSB, respectively; the CA3338A specs ¾ and ½ LSB for the same parameters. Both versions can operate at a typical data-update rate of 50 MHz.

The converters operate from a 5V supply. Because they are fabricated in CMOS SOS, they can generate rail-to-rail output swings. Their typical glitch energy is 150 pV·sec. All inputs are TTL compatible. Both versions accommodate unipolar or bipolar operation.

Both converters deliver data to the output 22 nsec after input changes. They come in either 16-pin plastic DIPs or 16-lead welded-seal ceramic packages. The plastic-packaged devices operate over −40 to +85°C; those in ceramic packages operate over −55 to +125°C. CA3338E, $7.90; CA3338AE, $11 (100).

GE/RCA Solid State Div, Route 202, Somerville, NJ 08876. Phone (201) 685-6994. Booth No 1330.

INQUIRE DIRECT



I/O MODULES

IA8 Series solid-state I/O modules feature a hybrid thick-film design enclosed in an 8-pin DIP. They provide a reliable means of interfacing μP- or computer-based control systems with external control devices and telecommunications equipment. The modules have terminals spaced on a 0.1-in. grid, so they're suitable for automatic insertion on pc boards. Surface-mountable versions

are also available. All the modules are designed to meet the applicable UL and CSA requirements.

IA8 modules can function as ac or dc input modules or ac output devices. Their maximum output is rated at 60V dc at 2A, and they require a 4 to 20V dc logic voltage in order to operate. All the units are optically coupled, and each provides 2500V rms input-to-output isolation. The modules withstand shocks of as much as 1500g for 0.5 msec and operate over −30 to +85°C. $3.68 (1000). Delivery, stock to 10 weeks ARO.

Potter & Brumfield, 200 S Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-2183. Booth Nos 2817, 2819, 2821, and 2823.

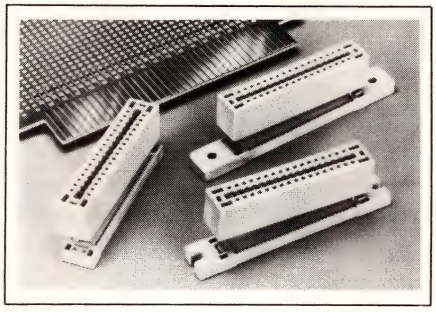
Circle No 553

CIRCUIT BREAKERS

Series 41-04-PR miniature circuit breakers can be mounted vertically or horizontally on pc boards. The circuit breakers are UL recognized and CSA certified, and they carry VDE and other worldwide approvals. Despite their size, these breakers provide dependable circuit protection. They are trip-free and foolproof, they cannot be held closed against an overload, and they will not cycle. Their current ratings range from 0.1 to 10A, and their maximum voltage ratings are 250V ac, 28V dc. The circuit breakers are also available in snap-in-mount or panel-mount versions. $2.60 (production qty).

E-T-A Circuit Breakers, 7400 N Croname Rd, Chicago, IL 60648. Phone (312) 647-8303. Booth Nos 323 and 325.

Circle No 556



CARD CONNECTORS

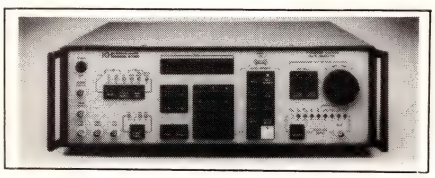
These card-edge connectors, members of the vendor's Lat-Con Series, are available in 20-, 26-, 34-, 40-, 50-, and 60-position sizes. They feature open-ended housings that permit the lateral insertion of 0.05-in. flat cable. This feature simplifies board assembly.

The connectors are available in three styles: without a flange, with an end-slotted flange, or with a full flange. The connectors are available with gold (15 or 30 μin.) or tin plating.

You can use the same connector for either end termination or daisy-chain termination. The lateral-entry feature permits very close daisy-chain configurations. A full range of termination equipment—from manual presses to high-volume, reel-fed equipment—is also available. The presses recess the cable from the edge of the connector. $0.045 per position (OEM qty).

Panduit Corp, 17301 Ridgeland Ave, Tinley Park, IL 60477. Phone (312) 532-1800. Booth Nos 1448, 1450, 1452, 1454, 1547, 1549, 1551, and 1553.

Circle No 550



SIGNAL GENERATOR

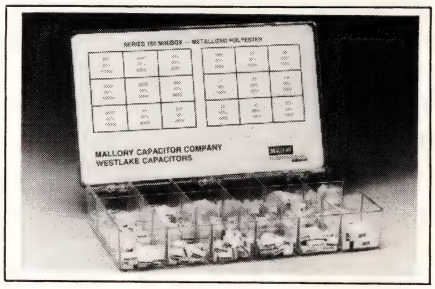
Model 2100 is a synthesized function pulse generator that's fully programmable over the IEEE-488 bus. The generator has a 0.01-Hz to 31.16-MHz frequency range, 0.00005% frequency accuracy, and 7-digit resolution. The main generator consists of two systems that offer precise sine, square, and triangle waveforms over the entire range; positive and negative pulses with rates as high as 10 MHz and rise and fall times of 11 nsec max; linear and exponential ramps with rates to 30 kHz; and an auxiliary TTL output.

The generator's output (open circuit) ranges from 10 μV to 30V p-p; it can be set in either ac peak or rms over the entire range. The instrument's operating modes include continuous, gate, trigger-burst, and linear/log sweep.

The 2100's internal nonvolatile memory allows you to store as many as 75 front-panel setups under program or front-panel control. Its other features include fixed and variable dc offsets, output protection, three modes of audible-tone selection, an internal clock, self-test, phase-lock monitors, and display messages. $3800. Delivery, 12 weeks ARO.

Krohn-Hite Corp, Bodwell St, Avon Industrial Park, Avon, MA 02322. Phone (617) 580-1660. TWX 710-345-0831. Booth Nos 1436 and 1438.

Circle No 560



CAPACITOR KITS

These engineering kits include a variety of metallized polyester capacitors, which are suitable for applications ranging from bypassing and decoupling to timing and tone generation.

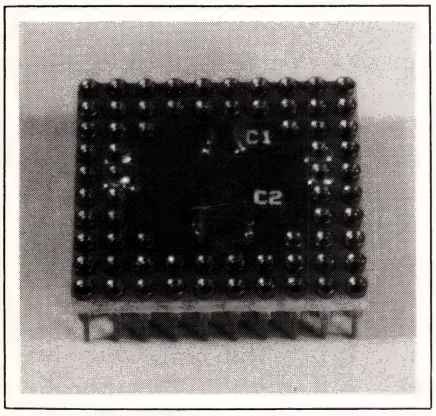
Two kits are available. One contains a variety of 167 and 168 Series radial leaded microminibox capacitors; the other includes Series 160

minibox devices. To ease prototyping and product development, the kits include capacitors of 18 different values (ranging from 1000 pF to 1 μF) with different tolerances and working voltages.

The vendor's entire 167/168 and 160 Series offer capacitors of 100 pF to 10 μF and tolerances of ±5, ±10, and ±20%. The capacitors operate over −55 to +125°C and spec a ±3 capacitance drift over two years at a temperature of 20 to 40°C and a relative humidity of 40 to 60%. 167/168 Series kit, $35; 160 Series kit, $25.

Mallory Capacitor Co, Box 372, Indianapolis, IN 46206. Phone (317) 261-1283. TLX 6876015. Booth Nos 2806 and 2808.

Circle No 552



PGA SOCKETS

These decoupled pin-grid-array (PGA) sockets feature integral, surface-mounted, decoupling capacitors committed to the appropriate voltage and ground locations. Two capacitors are included: a 1-μF capacitor for low frequencies and a 0.1-μF unit for high frequencies.

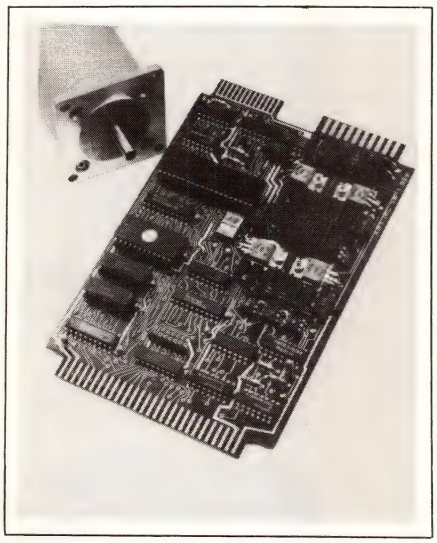
These sockets also employ a special ground plane as an interconnection vehicle between the ground termination of the capacitor and that of the socket, thus reducing inductance and providing a shield against noise. All the connections, including those to V_{CC}, are accomplished via direct soldering. The socket pins are all screw-machined terminals that incorporate a low-insertion-

Electro/87 Products

force, 4-finger beryllium-copper contact. The sockets decouple and mate with specific gate-array devices. For complete gate-array part-number references, contact the factory. $8.99. Delivery, four to eight weeks ARO.

Electronic Molding Corp, 96 Mill St, Woonsocket, RI 02895. Phone (401) 769-3800. TWX 710-387-1350. Booth Nos 2106 and 2108.

Circle No 554



MOTOR CONTROLLER

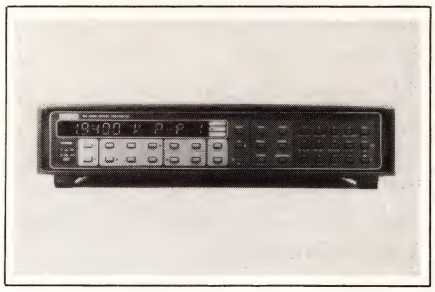
The SM-4 dual-axis motor controller and chopper driver is a single-board translator that's capable of driving two 6-wire step motors with ramped speeds in excess of 12,000 steps/sec. The controller has a repertoire of more than 30 commands (including loop on port or count, delays, and set/clear ports), and it also implements jog, limit, and home sensor inputs.

Each axis can store single or multiple application programs in the board's nonvolatile EEPROM. The SM-4's high-level instructions include loop, loop on port, trace, and single step. The board lets you edit, execute, and debug programs in interactive or program mode.

You can store all motor-control parameters, including initial and final velocities; relative/absolute mode; jog speeds; phase energize; and ramp factor. The stored information is available after reset or power-up. Users can initiate programs with the GO command or by strobing the bidirectional GO port. $830.

Advanced Micro Systems Inc, 31 Flagstone Dr, Hudson, NH 03051. Phone (603) 882-1447. Booth No 535.

Circle No 555



VOLTMETER

Model 194 combines the features of a waveform analyzer with those of a system voltmeter. As a waveform analyzer, the 194 can digitize signals at 1-MHz sampling rates with 8-bit resolution. As a voltmeter, it has a 16-bit mode that accommodates sampling rates to 100 kHz and offers a dynamic range of 10 μV to 200V.

The 194's data memory can store 65,000 samples in the 8-bit mode and 32,000 in the 16-bit mode. It stores either pre- or post-trigger data. The programmable sample period (from 1 μsec to 1 sec) has a 0.1-μsec increment over the entire range.

Model 194 can perform average, true-rms, standard-deviation, integration, and peak-to-peak computations on stored samples. It can also identify the positive peak, the negative peak, and the value of the sample at the trigger point. With an optional second channel, the 194 can compute the ratio and difference of a computed parameter from each channel.

All the instrument's controls and functions, along with 18 trigger modes, are programmable over its IEEE-488 bus. You can transfer stored samples over the bus at 90k

SIEMENS

High performance for low-current applications

Miniature relay D2

Siemens offers a highly extensive range of tried and tested electromechanical components, plus all the experience of a manufacturer who has consistently invested a great deal of know-how in developing and perfecting electromechanical components geared to market requirements.

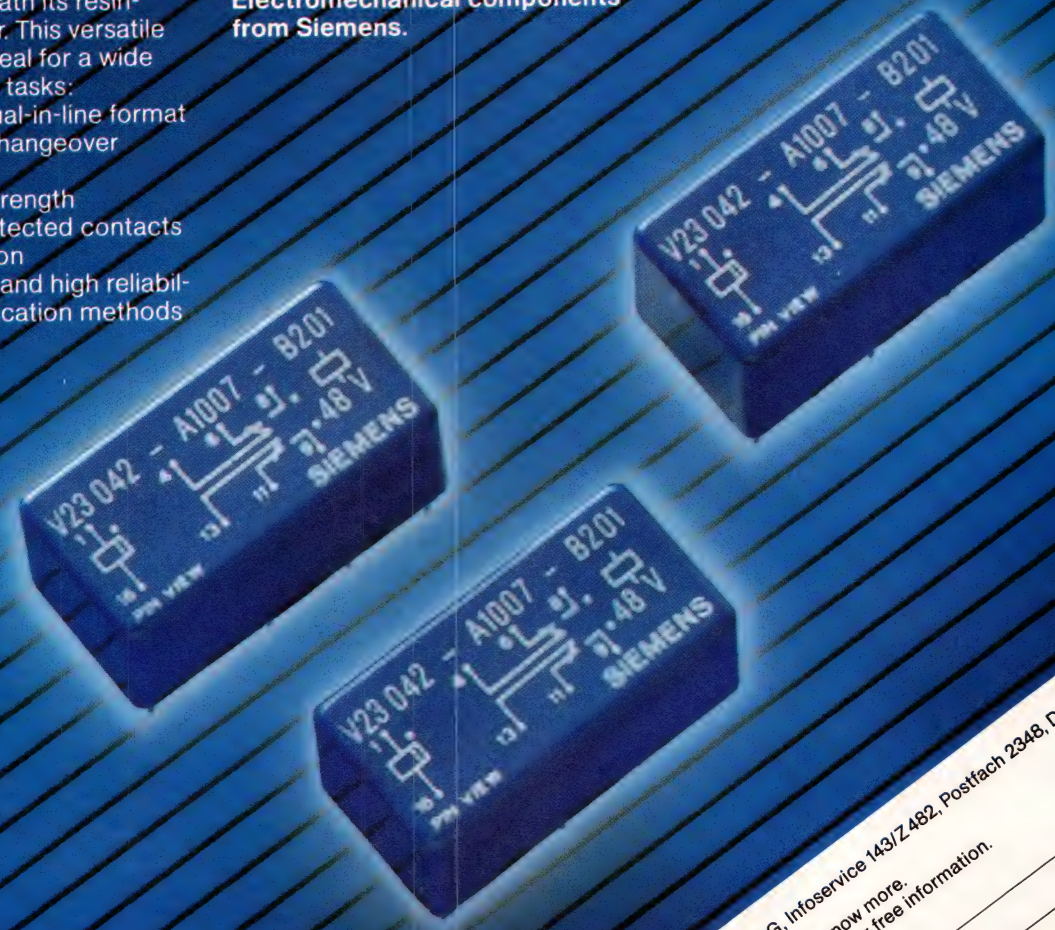
The miniature relay D2 is a typical example. Intelligent technology lies encapsulated beneath its resin-sealed plastic cover. This versatile relay is therefore ideal for a wide variety of switching tasks:

- Terminals with dual-in-line format
- Fitted with two changeover contacts
- High dielectric strength
- Atmosphere-protected contacts
- Slideless actuation
- Long service life and high reliability due to new fabrication methods

This makes the miniature relay D2 the universal interface device in every field of communication engineering.

All the other features of the miniature relay D2 are detailed in a special publication. If you would like one, please use this journal's reader service or send us the coupon.

Contacts you can rely on. Electromechanical components from Siemens.



CIRCLE NO 88

Coupon: To Siemens AG, Infoservice 143/Z 482, Postfach 2348, D-8510 Fürth 2
EDN033187

Yes, I would like to know more.
Please send me further free information.

Name _____

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Place/Postcode _____

Country _____

A 19100-N61-Z4-X-7600

Electro/87 Products

bytes/sec. Model 194, $3995; second channel (Model 1944), $1895.

Keithley Instruments Inc, 28775 Aurora Rd, Cleveland, OH 44139. Phone (216) 248-0400. TLX 985469. Booth Nos 1879 and 1881.

Circle No 561

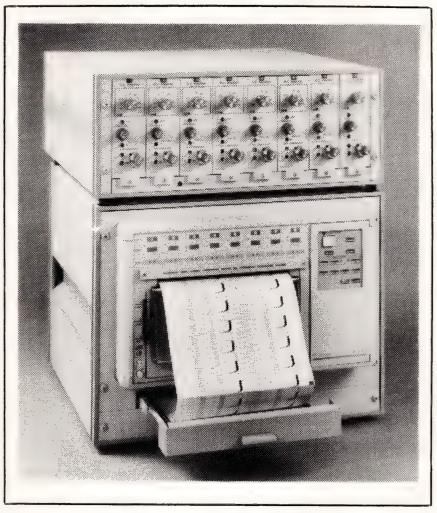


CHART RECORDER

The TA2000 8-channel recorder features a fixed array of thermal writing styluses that provide a 200-mm max recording width with 8-dot/mm resolution. The unit has a simple front panel that provides immediate and convenient access to common recorder controls, and it includes a cover for special-function keys not used in routine operation.

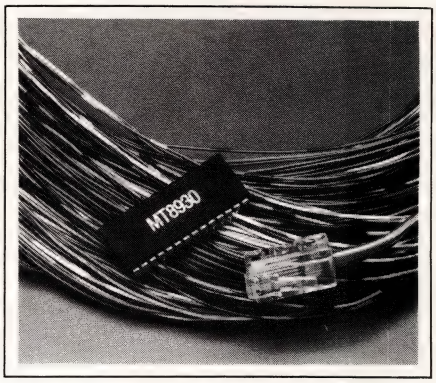
Its front-panel controls include three sensitivity selections, trace positioning in exact 1-cm increments, and an LED display that lets you identify the trace position and verify the signal amplitude. These functions allow you to overlap traces without using a peripheral device, and they let you quickly reformat the chart to meet specific application requirements.

The chart has three operating modes: continuous, periodic, and alternate. Time, date, chart-speed, and channel-identification annotations are automatic, and an RS-232C interface provides control of front-panel functions, full-page annotation, and 9-character parameter identifier.

Five grid-pattern selections are standard. The TA2000 also features timing and event marks, and it can use low-cost thermal paper. The recorder is available in desktop, portable, and rack-mount configurations. $10,200.

Gould Inc, Recording Systems Div, 3631 Perkins Ave, Cleveland, OH 44114. Phone (216) 361-3315. Booth Nos 1725, 1726, 1727, 1728, 1729, and 1730.

Circle No 559



INTERFACE IC

The MT8930 subscriber network interface circuit (SNIC) is a multifunction transceiver that provides a complete interface to the S/T reference points, as specified in the CCITT I.430 recommendations. Implementing both point-to-point and point-to-multipoint voice/data transmission, the SNIC can be used at either end of the digital subscriber loop. A programmable digital interface allows you to configure the MT8930 as a network terminator (NT) or as a terminal-equipment (TE) device.

The SNIC supports 192k-bps full-duplex data transmission on a 4-wire balanced transmission line. It provides transmission capability for both B and D channels, as well as related timing and synchronization functions, on chip. The MT8930 provides a signaling capability and has procedures for activating and deactivating TEs when necessary.

The chip handles D-channel resource allocation and prioritization for the resolution of access conten-

tion, and it handles signaling requirements in passive bus-line configurations. It provides control and status information that allows you to implement maintenance functions and monitor the chip and subscriber loop. $16 (1000).

Mitel Semiconductor, 2321 Morena Blvd, Suite M, San Diego, CA 92110. Phone (619) 276-3421. TWX 910-335-1242. Booth No 2027.

Circle No 557

DMOS FETs

BST100 and BST110 P-channel FETs come in TO-92 packages to accommodate standard mounting procedures. Models BST120 and BST122 are SOT-89 surface-mount versions of the BST100 and BST110. These DMOS FETs have a vertical crystal configuration, which provides drain-to-source on-resistance of 4.5Ω typ for the BST100 and BST120 with a gate-to-source voltage of 10V.

The short active channels also lead to fast switching times. Typical turn-on time for the 110 and 122 is 4 nsec under rated conditions. The maximum rated drain-to-source voltage is −60V for the BST100 and BST120 and −50V for the BST110 and BST122. The devices are available in both bulk and tape-and-reel packaging styles. The TO-92 devices cost $0.45; the SOT-89 parts are $1.50 (1000).

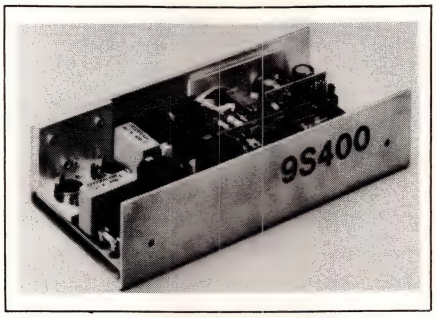
Amperex Electronic Corp, George Washington Hwy, Smithfield, RI 02917. Phone (401) 232-0500. Booth Nos 1744 and 1746.

Circle No 558

POWER SUPPLY

The 9S400 single-output power supply employs the vendor's "harmonic resonant" technology, which utilizes pulse-width modulation at a 200-kHz switching frequency. The supplies are UL recognized, CSA certified, and VDE approved for SELV applications.

The supply is available in four



output voltage/current configurations: 5V/80A, 12V/34.7A, 15V/28.2A, and 24V/18A. All versions include protection against overload, short-circuit, reverse-polarity, overvoltage, and overtemperature conditions.

The 9S400's dual input voltage ratings—90 to 132V ac and 180 to 264V ac at 47 to 63 Hz—allow it to operate from virtually any line voltage in the world. Its line regulation is 0.2% for high-to-low line change, and its load regulation is 0.2% for a 0 to 100% change. The supply's holdup time measures 20 msec min at nominal line voltage under full rated loads, and its ripple and noise is 50 mV p-p max. $300 (OEM qty). Delivery, 12 to 16 weeks ARO.

Sierra Power Systems, 20500 Plummer St, Chatsworth, CA 91311. Phone (818) 998-9873. Booth Nos 860 and 862.

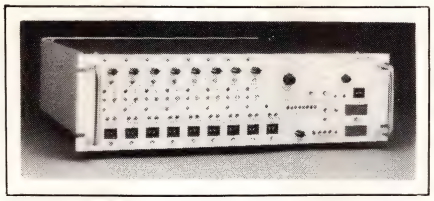
Circle No 562

DATA SYSTEM

An 8-channel, transient-data-acquisition system, the TDA 3500, is designed to capture and store high-frequency nonrepetitive data. It can operate in series with an oscillographic recorder, in parallel with real-time recorders, or as a standalone unit.

The TDA 3500 features a ±50 mV to ±500V voltage range. Direct-reading controls, grouped by function, eliminate the need to make calculations during setup and playback. You can trigger the system via any or all of the eight active channels. The system also has an external trigger capability and direct-reading pretrigger controls.

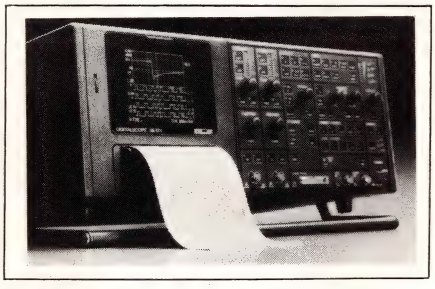
Electro/87 Products



The data-acquisition system has an effective bandwidth of 200 kHz at a rate of 10 samples per cycle. The system selects an antialiasing filter to correspond to each sample rate. Each channel has 512k bits of memory. An LED display readily identifies the run number and sample length of each record. $9700.

Western Graphtec Inc, 12 Chrysler St, Irvine, CA 92718. Phone (800) 854-8385; in CA, (714) 770-6010. Booth No 1671.

Circle No 563



STORAGE SCOPE

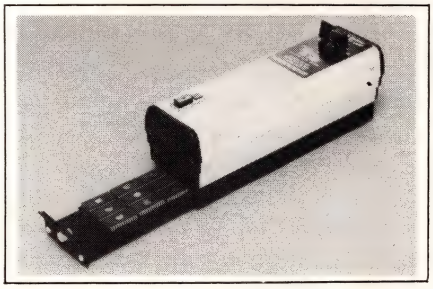
The SE 571 digital storage oscilloscope has a built-in compact thermal printer that quietly prints all the information from the CRT, complete with protocol of measurement, within 10 sec. Its 2-channel autoranging capability automatically selects the amplifier's sensitivity and timebase, and indicates this data on front-panel LEDs as well as on the CRT.

Equipped with two 25-MHz A/D converters, the SE 571 displays two signals of as much as 10 MHz each via nonlinear sine interpolation. For digital-circuit analysis, it provides as many as eight logic channels that can be displayed versus time or in sequence. With the instant printout capability, the SE 571 becomes an 8-channel logic recorder.

The cursor-control function accommodates amplitude and timebase analysis. Other functions can add, multiply, and average signals. The scope's nonvolatile memory can store as many as 20 waveforms. The instrument can also make unattended measurements: it has a real-time clock and an automatic print mode. An IEEE-488 interface is optional. $6500.

BBC-Metrawatt/Goerz, 2150 W 6th Ave, Broomfield, CO 80020. Phone (303) 469-5231. TLX 4970869. Booth Nos 2805 and 2807.

Circle No 564



EPROM ERASER

The PE-140T UV EPROM-erasing lamp, a desktop unit, has a speed and load capacity that's suited to the needs of individual and small-system users. With a 254-nm intensity of 8000 $\mu W/cm^2$, it can completely erase a chip in only 13 minutes. The $2\frac{7}{8} \times 10\frac{3}{4} \times 3\frac{7}{8}$-in., 3-lb unit can erase as many as nine EPROMs at a time.

To protect EPROMs from damage, the PE-104T includes a conductive foam pad that reduces electrostatic buildup. It also has a 60-minute timer that automatically shuts it off at the end of the erasing cycle.

The high-intensity, shortwave UV tube is fully enclosed in a rugged, anodized-aluminum housing. In addition, an interlock mechanism protects users from accidental exposure to hazardous UV radiation. The PE-140T is UL listed, and it meets OSHA safety standards. $139.

Spectronics Corp, Box 483, Westbury, NY 11590. Phone (516) 333-4840. TWX 510-222-5877. Booth No 1944.

Circle No 565

Two-chip modem suits high-speed LAN systems

For your local-area-network applications, you can use a 2-chip modem to communicate over a coaxial cable at 8M bps max. At 500k bps, the cable can be as long as 19 miles without needing repeaters. By adding simple filters, you can connect multiple modems to the same cable in a multichannel system.

Prasanna M Shah, *Signetics Corp*

Modems that employ the frequency-shift-keying (FSK) modulation technique are particularly suitable for LAN applications because of their high noise immunity and amplitude independence, which together yield a low bit-error rate. FSK modems are also relatively easy to construct and are, therefore, inexpensive in comparison with those employing more esoteric modulation techniques. Low-speed FSK modems have been available in ICs for some years but, until recently, FSK modems that could operate at speeds higher than 19,200 bps were available only at the board level and employed many discrete and small-scale-integration (SSI) components.

Now, however, you can obtain a complete, high-speed modem in the form of two ICs: the NE5080 transmitter and the NE5081 receiver. These ICs can provide transmission rates as high as 8M bps, depending on the attenuation characteristics and the length of the cable you use to connect the nodes.

Over a short length of low-loss 75Ω coaxial cable, you'll be able to achieve the full speed of the modem, but the maximum error-free transmission rate will decrease as the cable length increases. Nevertheless, you'll still be able to achieve a transmission rate of 500k bps over a 100,000-ft length of cable (almost 19 mi) without any repeaters. You can adjust the sensitivity of the receiver to compensate for the cable length and for the noise level of the environment. For a signal-to-noise ratio of 20 dB, the typical error rate of a link using this modem is one in 10^{12} bits.

The NE5080 transmitter IC, which consists of six functional blocks **(Fig 1)**, contains an on-chip voltage regulator that provides the current and voltage references used by the internal circuitry. You can adjust the transmitter's center frequency by selecting appropriate values for the tuning capacitor (C_O) and resistor (R_{CS}).

The TTL data-input circuits and their associated switch-driver circuits switch the current sources (I) into or out of the circuit according to the present value of the input bit. The switching process changes the total average current that charges or discharges C_O from 1.5I to 2.5I, or vice versa. The change in current

The FSK-modulation technique provides high noise immunity and yields a low error rate.

causes the current-controlled oscillator to shift its output from one frequency to another in a manner that keeps the output phase continuous and eliminates sharp discontinuities in the output waveform. This Continuous-Phase FSK (CPFSK) technique has the advantage of confining most of the power to the main lobe of the spectrum; the consequent reduction of the power radiated into the sidebands reduces adjacent-channel interference **(Ref 1)**.

The ratio of the two output frequencies is equal to the ratio of the average currents that charge and discharge C_O. The values of the current sources are fixed, and they normally yield a constant frequency ratio (f_0/f_1) of 1.666; however, by adding external components you can modify this ratio, which determines the bandwidth used by a particular channel.

The transmission chip's triangle-to-sine-wave converter circuitry converts the triangular output of the current-controlled oscillator to a sine wave that has a total distortion of 2% or less. The transmission-gating circuits permit or prevent the transmission of data. The disable function not only puts the 3-state output buffer into the high-impedance state but also shuts off the current-controlled oscillator so as to prevent any feedthrough to the output circuit.

The chip's jabber-control circuits are similar to its transmission-gating circuits, except that the jabber-control circuits provide a means of programming the length of the transmission. This feature acts as a failsafe that prevents a malfunctioning NE5080 transmitter or transmitter controller from tying up the network. To make use of the feature, you can connect an external capacitor from the chip's jabber-control pin (pin 3, not shown in **Fig 1**) to ground; an internal current source provides a small current to charge this capacitor. When the voltage across the capacitor reaches a preset threshold level, the jabber-control circuits disable the output buffer and shut off the oscillator. For point-to-point communications, which do not need the jabber-control feature, you can disable the circuitry by grounding pin 3.

You can adjust receiver sensitivity

The NE5081 receiver IC **(Fig 2)**, like the NE5080 transmitter, contains an on-chip voltage regulator that provides all the voltage- and current-reference levels needed by the internal circuitry. The input-limiter circuits accept the incoming FSK signal and maintain their output amplitude at a constant level for all input-signal amplitudes ranging from 16 to 1100 mV rms.

A phase shifter and a balanced analog multiplier use a quadrature-detection scheme to demodulate the incoming data. To use the receiver IC, you need to select the values of the phase-shifter tank circuit (L_1 and C_1)

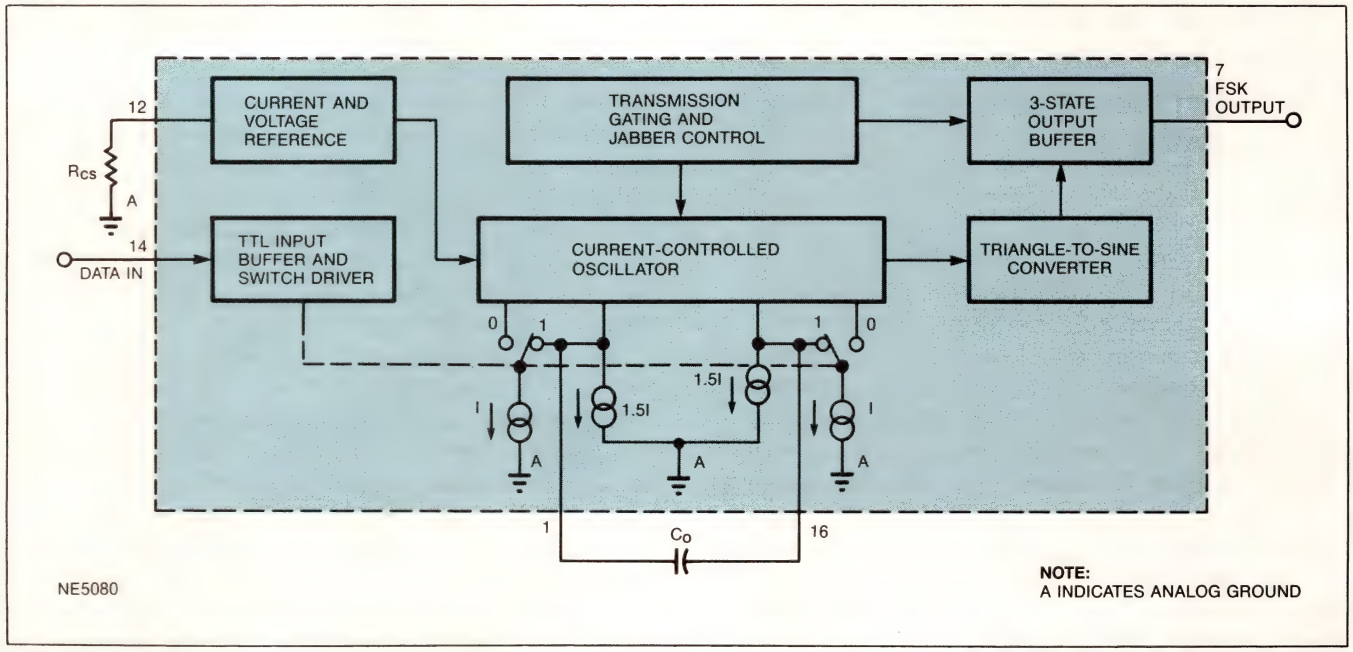


Fig 1—This FSK transmitter chip *works at frequencies as high as 8 MHz. You can set the transmitter center frequency by means of external trimming components.*

to resonate at the center frequency of the incoming carrier. To ensure good selectivity, you must design the tank circuit so that it has a high Q factor. The balanced analog multiplier accepts both the original amplitude-limited carrier signal and the phase-shifted derivative, and it generates signals containing both the baseband data and high-order harmonics.

A simple, second-order Butterworth lowpass filter eliminates the original carrier frequency and the high-order intermodulation products. The output of the filter contains only baseband data that is the equivalent of the original data applied to the transmitter at the remote end of the link. External resistors and capacitors allow you to adjust the filter's cutoff frequency.

A comparator determines the status of the input bit by comparing the output of the lowpass filter to a programmable reference threshold. By means of an external resistor, you can set the threshold of the

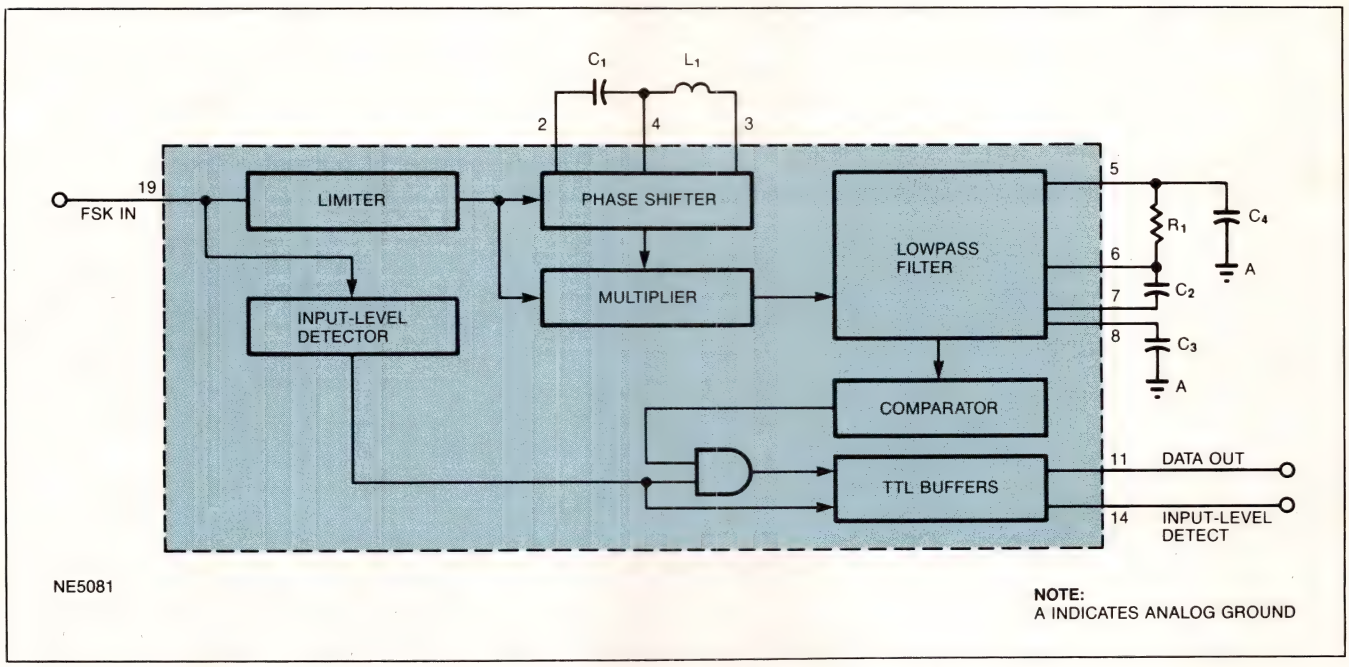


Fig 2—This FSK receiver chip uses quadrature detection. *It automatically disables the output buffers when the input signal falls below a preset threshold.*

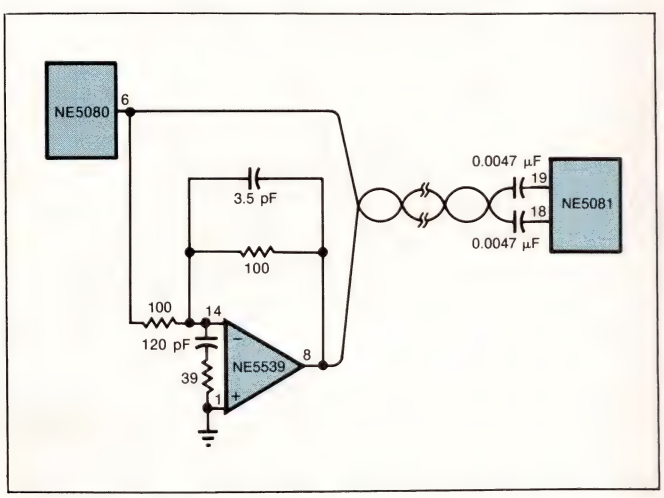


Fig 3—The transmitter IC can drive a twisted-pair cable *if you add an inverting amplifier to drive the out-of-phase line.*

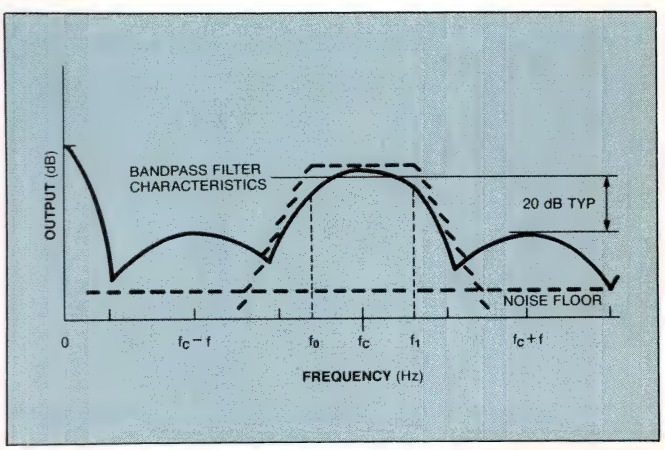


Fig 4—Sidebands are 20 dB below the main lobe *in this spectrum of a typical NE5080 chip's transmission of pseudorandom data. The frequency ratio, f_1/f_0, is internally set to 1.666, but it can be modified by external components.*

Connecting several modem channels to a single coaxial cable in a frequency-division multiplexing scheme makes efficient use of the cable.

input-level-detection circuitry to correspond to the minimum input-signal amplitude that is detectable above the noise floor. If the input signal amplitude falls below this preset threshold, the level-detection circuitry disables the receiver output buffers so that noise will not be interpreted as data. The level-detection circuitry also generates a flag signal; when the flag is at logical one, the input-signal amplitude is above the threshold, and the output buffers are presenting valid data.

The transmitter's high drive capability and the receiver's wide dynamic range allow you to use long lengths of cable (as long as 19 mi) without any repeaters. Furthermore, you're not limited to coaxial cable; you can use twisted-pair cable, provided that you drive it differentially.

The receiver chip has built-in differential input circuits, so you won't need any extra components at that end of the link. The transmitter chip has a single-ended output, so you'll need an inverting amplifier to provide the inverted signal to the line. A single amplifier based on an op amp with a wide unity-gain bandwidth (**Fig 3**) is usually adequate for this purpose. However, if you find that your inverting amplifier causes severe phase delay (which could impair the link's noise immunity or error rate), you'll have to add a matching noninverting amplifier to drive the in-phase line and restore the phase balance.

Although a link employing these transmitter and receiver ICs has high inherent immunity to noise, some situations may require you to take additional precautions. The ambient electrical-noise floor in a factory environment, for example, is much higher than that of

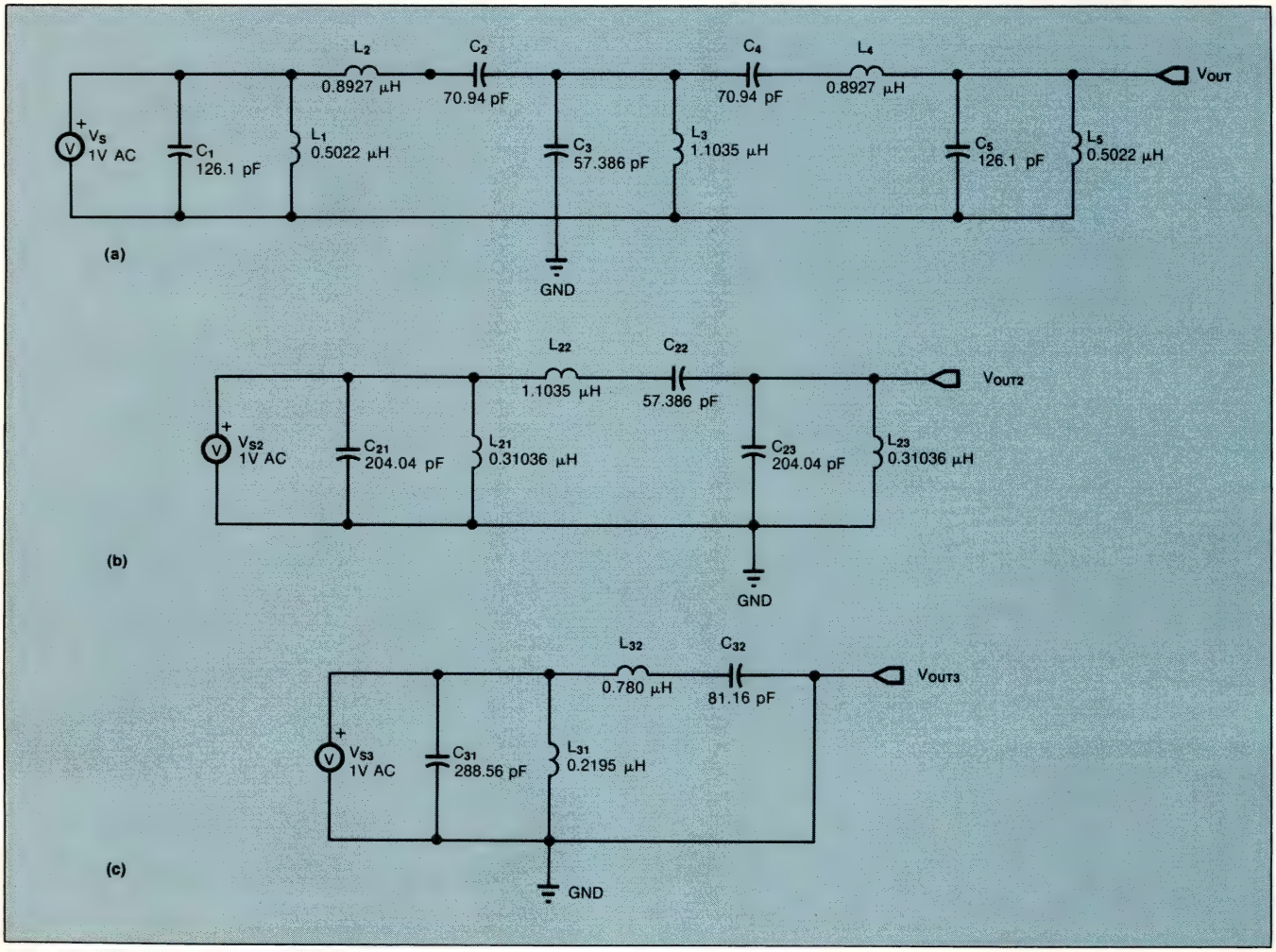


Fig 5—These Butterworth filters are tuned to 20 MHz. *The 2-pole version* ***(a)*** *is often adequate for a frequency ratio of 1.666. For smaller ratios, you'll need the sharper cutoff of the 3-pole* ***(b)*** *or 5-pole* ***(c)*** *versions in order to eliminate the sidebands.*

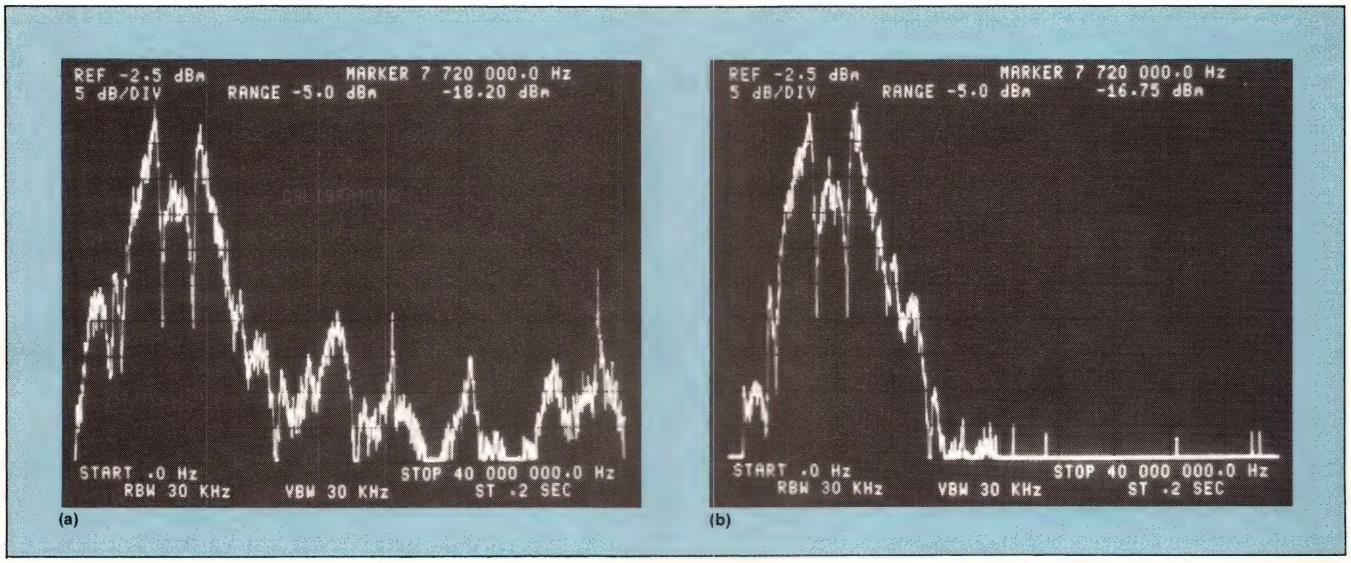


Fig 6—Sidebands have significant amplitude *in the unfiltered output spectrum* ***(a)*** *of an NE5080 transmitting on a center frequency of 7.7 MHz. Adding a filter* ***(b)*** *almost completely eliminates the sidebands.*

an office environment because of the EMI/RFI generated by heavy-duty machines. The bit-error rate of a link is a function of the S/N ratio. Thus, to improve the bit-error rate in a noisy environment, you must filter out the excess noise power at the receiver input.

Your choice of active or passive filters for this purpose will depend upon the signal strength at the receiver input. If the signal strength is great, you can use an inexpensive passive LC bandpass filter. For low signal levels, an active filter will boost the in-band signal while attenuating the out-of-band noise.

If you elect to use a passive filter, you should keep the Q factor of the circuit as high as possible. To minimize the attenuation of the in-band signal, you should make sure that the Q factor is at least 35. The filter's characteristics will depend upon the spectrum of the transmitted signal.

Fig 4 shows a typical spectrum at the output of an NE5080 that is transmitting a pseudorandom data stream. The figure indicates the filter characteristics needed to eliminate the sidebands and out-of-band noise. You can use 2-, 3-, or 5-pole Butterworth passive filters for this purpose (**Fig 5**). **Fig 6** shows the actual spectra obtained in a test of the chip's transmission of a pseudorandom data stream at 7.7 MHz, with and without the 5-pole filter. This filter attenuates the sidebands and the out-of-band noise by more than 40 dB, so it yields a much-improved S/N ratio and a lower bit-error rate.

When designing active filters for a high-frequency carrier, be sure to pick an amplifier with the widest possible unity-gain bandwidth; the NE5539, for example, is well suited to this application because of its 350-MHz unity-gain bandwidth (**Ref 2**).

You can extend the principle of filtering sidebands and out-of-band noise to create a multichannel frequency-division-multiplexed (FDM) system. The modem

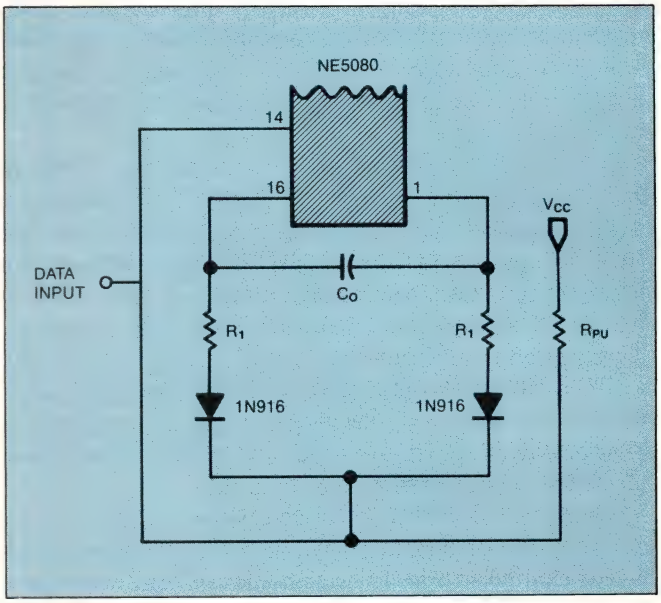


Fig 7—Capacitor C_O determines the center frequency *of the NE5080. You can modify the frequency ratio by adding external components to raise the lower frequency or lower the upper frequency.*

The NE5080 transmitter has a constant frequency ratio of 1.666, regardless of the center frequency.

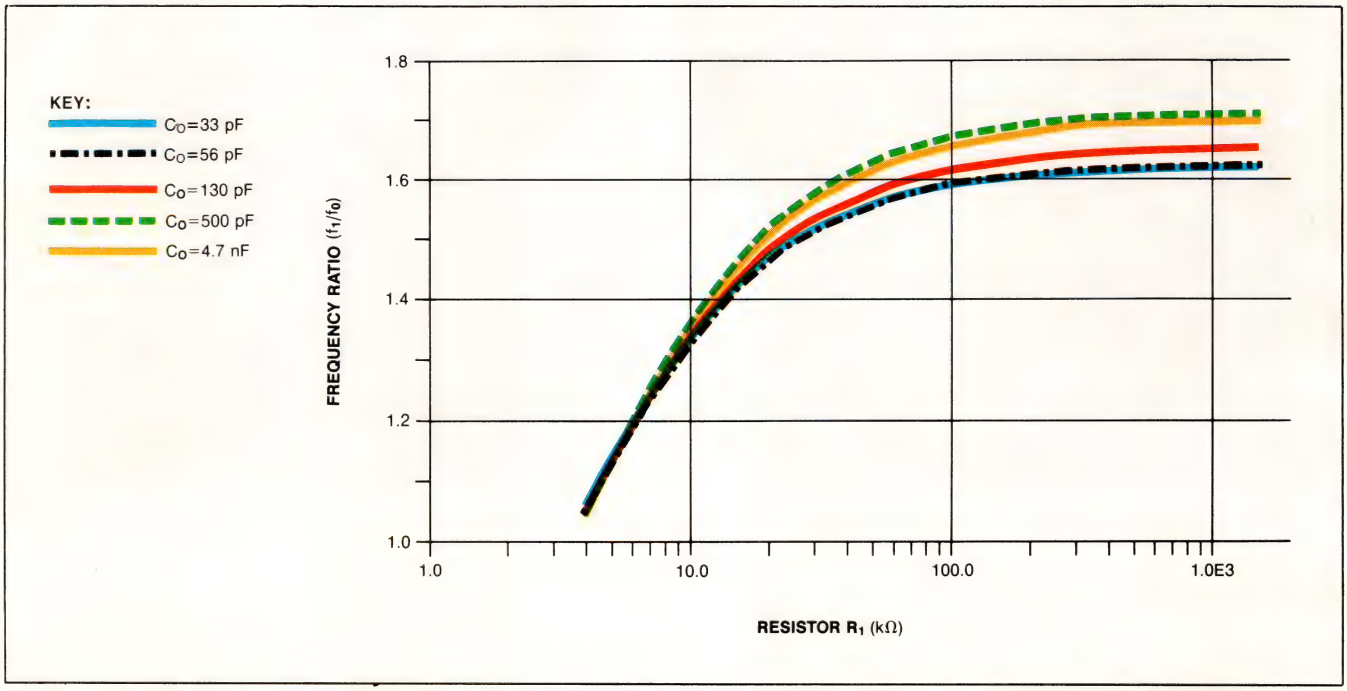


Fig 8—Frequency ratio is a function of resistor value *and is relatively constant over a wide range of center frequencies (determined by C_O). From this curve you can determine the resistor value that will yield the desired ratio.*

chip set can work over a wide range of center frequencies (from less than 50 kHz to more than 20 MHz). Thus, you can connect several transmitter/receiver pairs to the same coaxial cable to provide a multichannel FDM system. You can eliminate crosstalk between the channels by using an appropriate filter at each transmitter output and receiver input. This capability is important for several reasons.

First, an FDM system makes efficient use of one of the most expensive components in any digital communications network—the cable. Second, you can use the same pc-board layout for all of the FSK modems on the network; to change the center frequency, you need to modify the values of only a few resistors and capacitors. Third, you can upgrade the speed of any node on the network merely by removing the existing modem board and substituting a similar board that you've adjusted for the desired speed. You won't have to make any other hardware or software changes.

When you select the center frequencies of the various channels in an FDM network, make sure that the higher channels avoid the harmonics of the lower channels. For example, you can set the center frequency of the first channel to approximately 50 kHz, which will permit the channel to operate at a data rate of 19.2k bps. Because the frequency ratio (f_0/f_1) is 1.666, the band edges of this channel fall at 25 kHz and 75 kHz, so the total bandwidth is 50 kHz.

You can set the second channel's center frequency at 455 kHz. The band edges of this channel fall at 250 kHz and 750 kHz, so the bandwidth is 500 kHz, which permits a data rate of approximately 192k bps. You can center the third channel at 5 MHz, yielding a data rate of approximately 2M bps, and the fourth channel at 21 MHz, yielding a data rate of about 8M bps. Careful filtering of the sidebands in each channel will ensure high data integrity and will improve the overall performance of the system.

You can modify the frequency ratio

Although the frequency ratio, f_0/f_1, of the NE5080 transmitter is internally set at 1.666, you can change the ratio by raising the lower frequency (f_0) or by lowering the upper frequency (f_1). As a result, the main lobe of the spectrum is narrower, and the bandwidth occupied by the channel is reduced. There's a tradeoff to consider, however. The reduced bandwidth of each channel allows the cable to accommodate more channels but entails a poorer noise margin; thus, the probability of a bit error is slightly increased.

The technique for raising the lower frequency is shown in **Fig 7.** When the data input is a logic one, the

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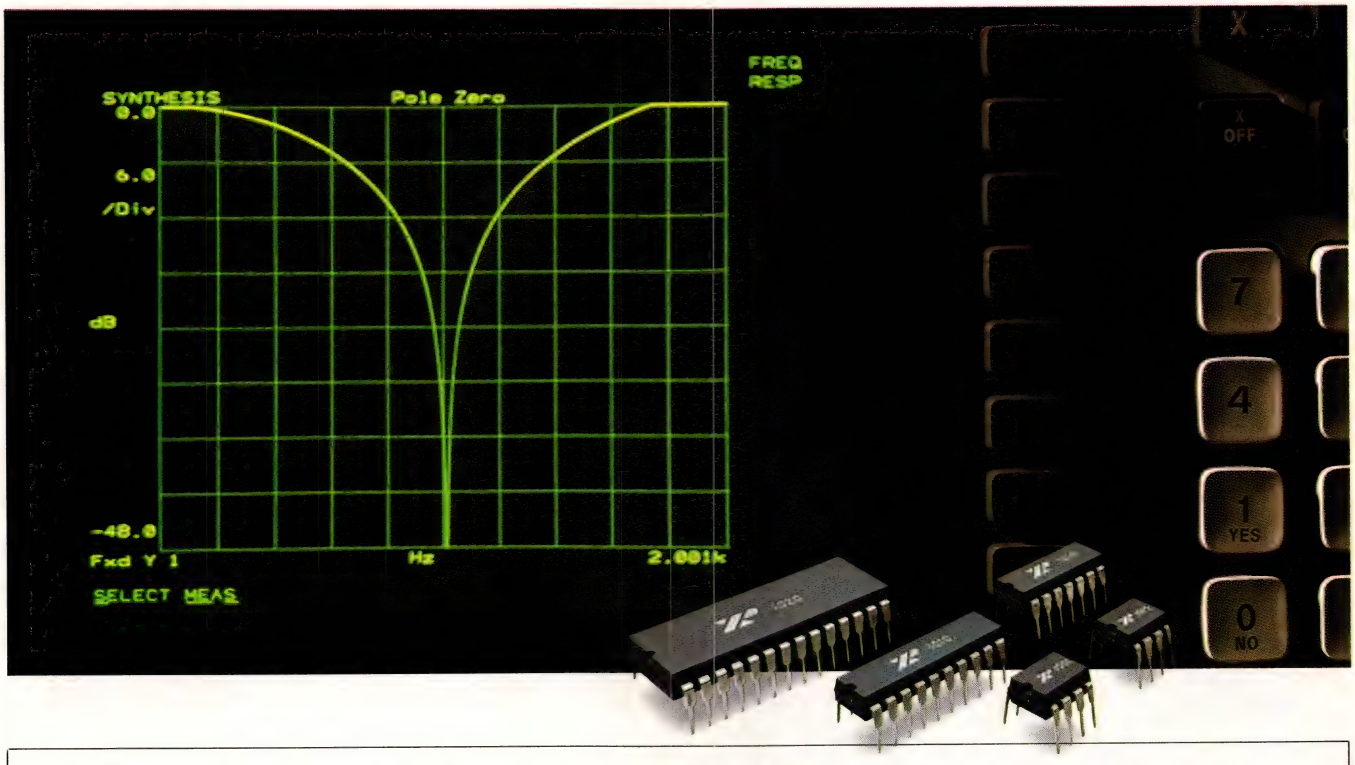

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	XR-2127	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	AMI S35212A compatible ALB test mode Call Progress monitoring
	XR-2128	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	ALB test mode Enhanced Call Progress monitoring (fo/2.5)
	XR-2129	Bell 212A/ CCITT V.22 CCITT V.22 bis	PSK/ FSK	1200/300/ 2400	CMOS	Designed to complement XR-2121/XR-2122/XR-2125 1.8432 MHz onboard oscillator Additional worst case line equalizer ALB test mode

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Filters that reduce the amplitude of the sidebands with respect to the main lobe of the spectrum can dramatically improve the performance of a comm channel.

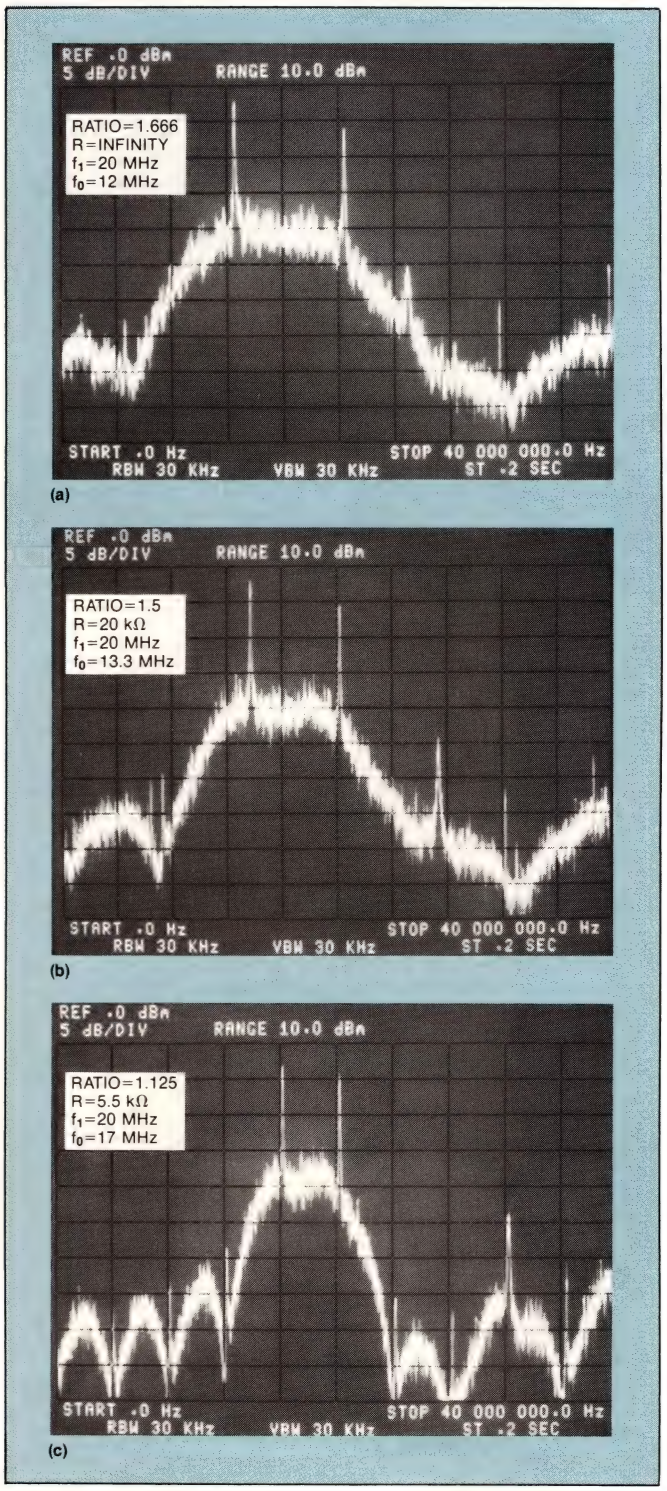

Fig 9—The main lobe of the resonant circuit narrows *as the frequency ratio is reduced. These photos show the effect of reducing the frequency ratio from the standard 1.666* ***(a)*** *to 1.5* ***(b)****, and then to 1.125* ***(c)****.*

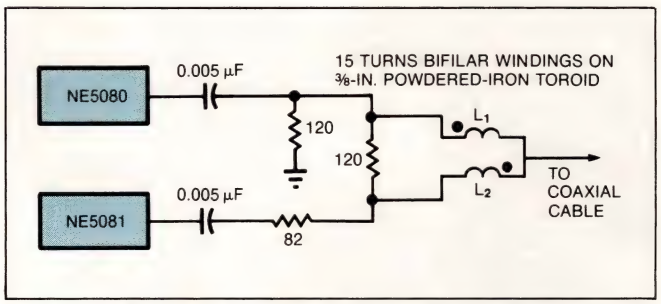

Fig 10—A hybrid coil permits full-duplex operation *over a single coaxial cable. The back-EMFs induced in the hybrid windings cancel both the local transmitter signal at the receiver input and the received signal at the transmitter output, so that the signals do not interact.*

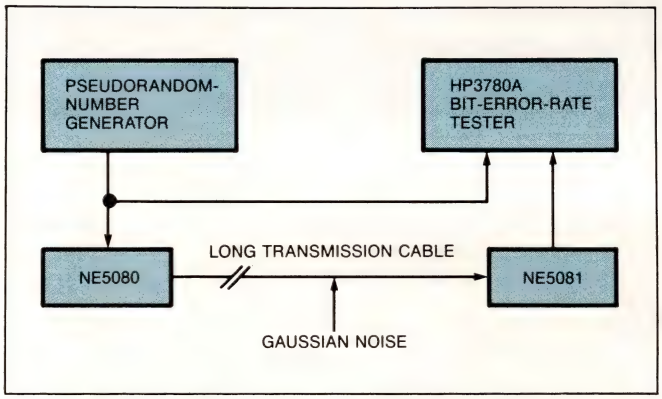

Fig 11—To determine a link's error rate*—which is a function of its S/N ratio—you can use an error-rate tester to compare the bits sent with the bits received over the link, or you can examine the eye pattern at pin 8 of the NE5081 receiver.*

input line is held at 5V through the pullup resistor, R_{PU}, and the two diodes are reverse-biased. Under these conditions, capacitor C_0 is charged and discharged from the IC's internal current sources. When the data input goes to a logic zero, the input voltage drops to almost 0V and the two diodes become forward biased. As a result, the total current available for charging and discharging capacitor C_0 is increased, and the output frequency of the current-controlled oscillator is decreased.

The value of the two matched resistors (R_1) determines the amount of additional current available, and thus the f_1/f_0 ratio; it's essential that you maintain a close match between the two resistors in order to avoid excessive distortion at the FSK output. In selecting diodes for this application, you should consider their switching speed and capacitance; the 1N916 is fast and has a capacitance of only 2 pF, but even faster diodes with lower capacitance (such as the FD777) are available.

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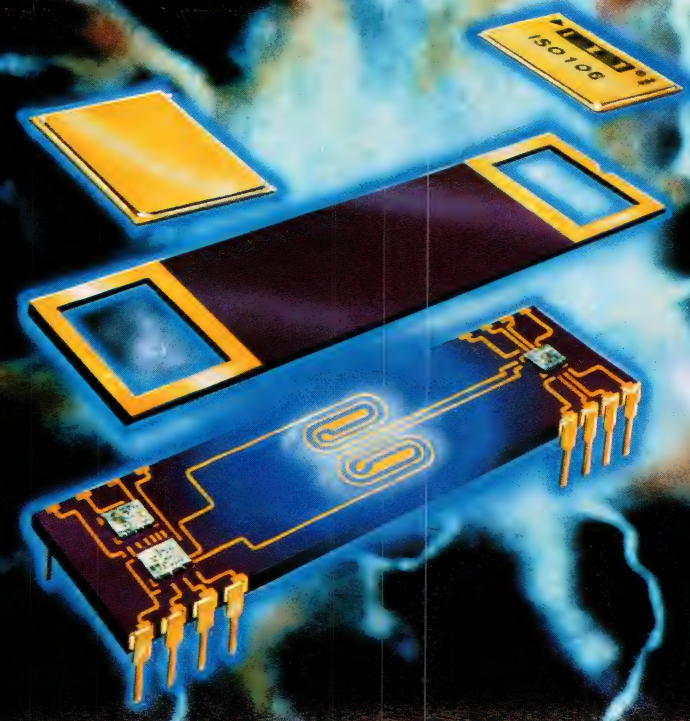

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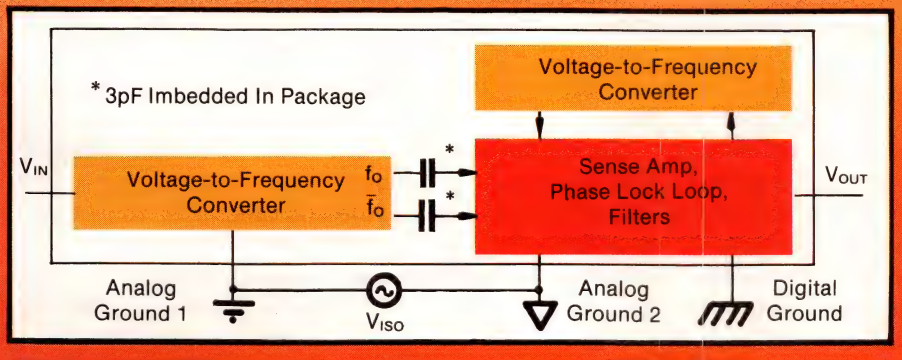

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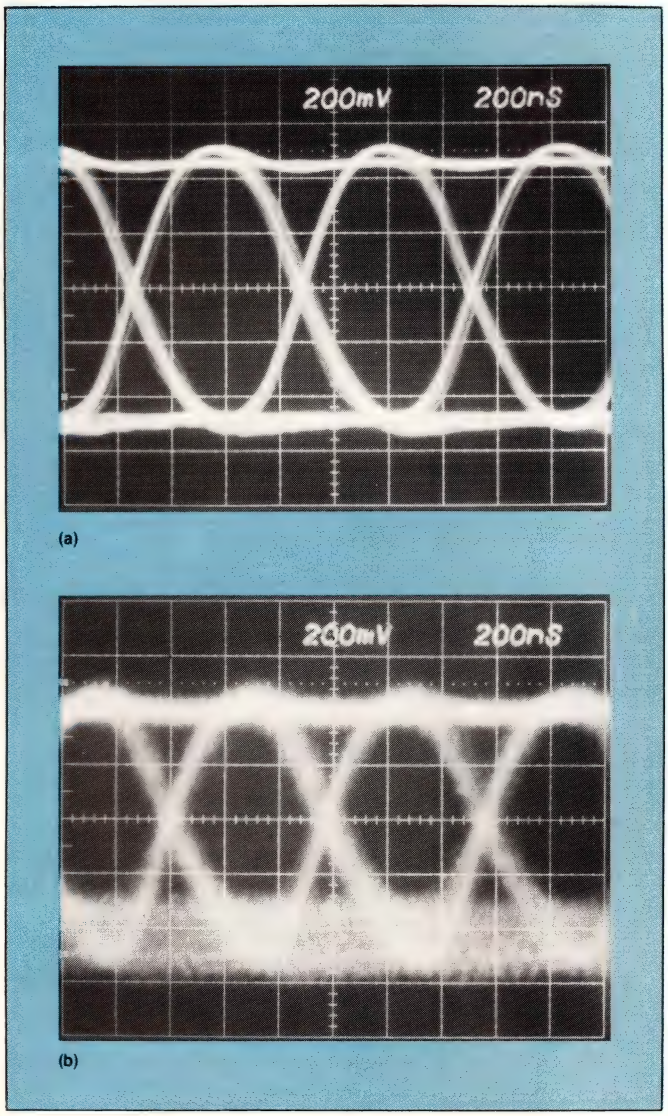

Fig 12—A clean eye pattern (a) *indicates low noise. The horizontal width of the eye is a function of timing jitter; the vertical height is a function of the noise received. The fuzzy trace and small opening in* ***b*** *indicate excessive noise and an unacceptably high bit-error rate.*

In making any modifications to **Fig 7**'s circuit, you'll have to take into account the stability of the ratio for a specific value of R_1 over a wide range of center frequencies. You can see from **Fig 8** that a channel's deviation ratio remains constant for a fixed value of R_1 over a wide range of values for capacitor C_0. You should note, however, that if you reduce the deviation from the center frequency, you'll also reduce the maximum data rate for that channel. Likewise, increasing the frequency ratio will increase the possible data rates, but at the cost of extra bandwidth. If you reduce the frequency ratio, you'll also have to increase the Q factor of the receiver tank circuit so that the main lobe of the resonant circuit becomes narrower, thus corresponding to the main lobe of the modified transmitter spectrum.

You can see the effect of reducing the frequency ratio in the spectrum photographs (**Fig 9**). The main lobe grows progressively narrower, and so the filter must have a sharp cutoff to ensure that the sidebands are attenuated by at least 60 dB with respect to the main lobe. You'll need to use a Butterworth filter with five or more poles, or a Chebyshev or ripple filter that provides even sharper cutoff than the Butterworth type does.

If you use a 20-kΩ resistor in the circuit shown in **Fig 7**, you'll achieve a frequency ratio of 1.5, as the curve in **Fig 8** shows. This ratio allows you to use a 30-MHz cable to accommodate six channels instead of four. If you reduce the ratio even further (for example, to 1.125), the same total bandwidth can accommodate many more channels.

A hybrid coil provides full-duplex capability

It's possible to make even more efficient use of your cable resources. So far, all the applications discussed have required two cables for full-duplex communication (simultaneous transmission and reception by a given channel). However, you can achieve full-duplex communication over a single coaxial cable by adding a hybrid coil (**Fig 10**). The hybrid coil consists of 15 turns of #24 AWG or #26 AWG bifilar windings on a powdered-iron toroid core.

The sinusoidal signal from the NE5080 transmitter enters the hybrid at the dotted terminal of winding L_1. Because of the mutual inductance of the windings, the transmitter signal induces an equal and opposite signal in winding L_2, which cancels the transmitter signal that reaches the receiver through the 120Ω resistor. Similarly, received signals entering the dotted terminal of winding L_2 create an equal and opposite signal in winding L_1. Hence, the incoming signal goes directly to the NE5081 receiver without interacting with the transmitted signal. The resistor values shown in the schematic yield an effective termination resistance of 75Ω.

The bit-error rate is the measure of data integrity within any data-communications network, so you should include a test of this parameter in your design procedures. A typical method of testing bit-error rate is to compare the bit stream applied directly to a bit-error-rate tester with the same bit stream that has

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MSA-0204	4.0	11.0	6.5	4.0	B	1.90
MSA-0370	4.5	12.5	5.5	10.0	C	16.10
MSA-0420	3.5	8.5	7.0	15.0	D	18.45
MSA-0635	4.0	16.5	3.0	1.5	E	4.85
MSA-0835	6.0	23.5	3.0	12.5	E	7.80
MSF-8870	8.0	20.0	N/A	9.0	C	29.75

A) 85 mil plastic B) 145 mil plastic C) 70 mil stripline
D) 200 mil BeO E) 100 mil ceramic

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passed through a modem link **(Fig 11)**.

There's another quick and easy way to evaluate the performance of the link, a method that doesn't require a bit-error-rate tester. You simply connect the pseudorandom-number generator, the transmitter, the cable, and the receiver, to establish a data link carrying a pseudorandom bit stream. Then you connect an oscilloscope to the receiver at pin 8, from which you can obtain an "eye" pattern **(Fig 12.)** If the eye pattern looks clean, you can be fairly certain that the system is relatively noise- and error-free. A fuzzy pattern with small openings indicates excessive noise, which would probably lead to data errors. **EDN**

Acknowledgment

The author is sincerely thankful to Michael Sera for his help in the passive bandpass filter designs, simulations, and applications testing.

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Author's biography

Prasanna Shah is an applications engineer at Signetics Corp's Linear Div, where he is responsible for modem products and other communications devices. Previously, he was a product engineer for interface and data-conversion devices in the same division. Prasanna holds a BSEE from the University of Santa Clara and an MSEE from Stanford University. In his leisure time he enjoys music, painting, and photography.

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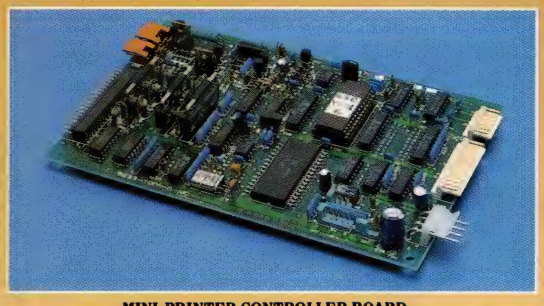

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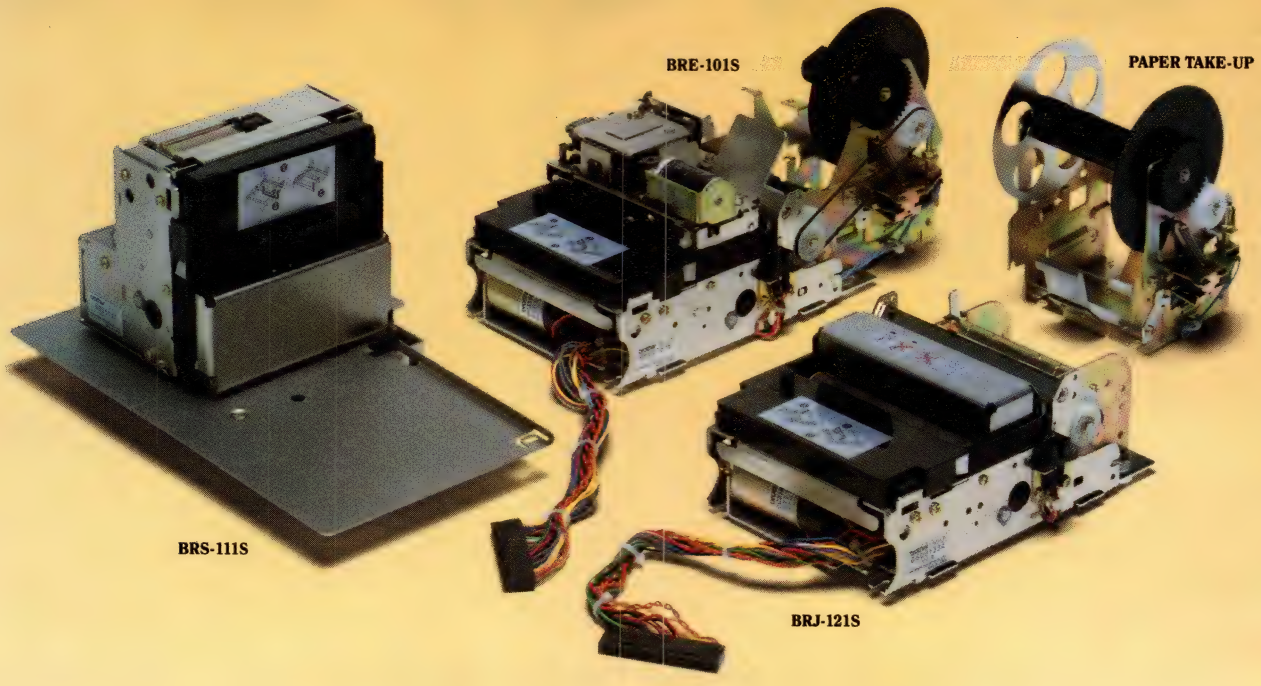

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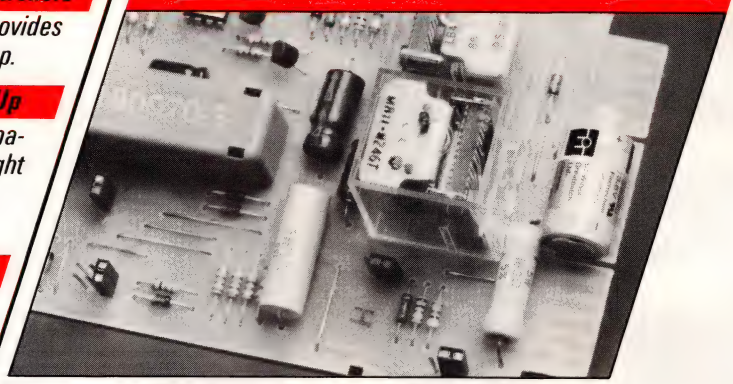

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Cathode	MnO_2	MnO_2	HgO	SO_2	$SOCl_2$	$SOCl_2/BrCl$	SO_2Cl_2/Cl_2	CuO
Electrolyte	$NH_4Cl_1ZnCL_2$	KOH	KOH	LiBr	$LiAlCl_4$	$LiAlCl_4$	$LiAlCl_4$	var.
Voltage								
Open Circuit V	1.6	1.6	1.35	3.0	3.6	3.9	3.9	2.4V
Typical Load V	1.4-1.0	1.4-1.0	1.3	2.8-2.7	3.5-3.4	3.7-3.5	3.8-3.5	1.5V
Energy Density								
Ah/cm^3	0.08	0.13	0.23	0.18	0.20	0.26	0.23	0.35
Ah/kg	47	55	76	100	92	120	110	180
Wh/cm^3	0.1	0.2	0.4	0.5	0.8	1.1	0.9	0.5
Wh/kg	66	77	100	300	400	440	410	300
D Cell Capacity Ah	2	4	10	8	10	14	12	20
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Microprogram monitor helps develop bit-slice designs

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Typically, when you develop code to control μP-based systems, you use a monitor program in conjunction with an emulator to display state information that can't be probed externally. Such information includes the contents of registers, stacks, and memory as well as the condition of internal flags. Microprogram development systems, in contrast, usually don't incorporate emulators and don't have monitor programs: Each microprogram design is unique, and you must therefore develop each monitor individually. Nonetheless, by using your knowledge of the target system that's under development and the tools that a microprogram development system has to offer, you can develop a system monitor capable of many of the valuable functions found on a microprocessor emulator.

When designing a microprogram monitor, you must take care to meet several conditions. The monitor must provide a way to break away from the application code under development and smoothly transfer control back to that code. When the control transfer takes place, the monitor must return the program flow to its point of departure. It must also ensure that the state of the target system isn't modified during this transfer. Because all monitor code runs on the target system, it's difficult to accomplish these control transfers without affecting the system state. You must latch volatile-status information to prevent losing any of it, and you must make sure that the monitor doesn't over-write nonvolatile status information.

Entering the monitor

When you enter the monitor, you change program flow. This redirection is a result of disabling the address output of the target system and then substituting a different address. Often, a microprogram sequencer provides this address during normal program flow—for example, the TI AS890 or the AMD Am2910. Both these chips have an output-enable pin, which allows you to disable the address output from the chip and take control of the microprogram address bus. Once you have control, the microprogram development system jams an address onto the bus.

What happens after that depends, in part, on the sequencer. The TI AS890, for instance, accepts the address being jammed as a source for updating its program counter. Thus, in this case, not only do you change program flow so that the next instruction executed is found at that address, you also update the program counter so that subsequent instructions are executed sequentially from locations immediately following the jammed location.

A sequencer such as the Am2910, on the other hand,

The monitor must provide a way to break away from the code under development.

requires that you have an instruction at the jammed address, which modifies the sequencer's program counter. One method involves writing one unconditional branch instruction in the writable control store. The branch instruction transfers control to the monitor and updates the program counter at the same time. Using this method, you can branch to any point in the monitor simply by updating the address field of the branch instruction.

Another method of control transfer possible with the Am2910 entails placing one unconditional-branch microword in your code for each entry point in the monitor. Using this technique, you can jam the address of the respective branch instruction and transfer control to different areas of the monitor without using any of the writable control store.

Back to the point of departure

The ability of the monitor to return to its point of departure within the microcode is essential. If the monitor didn't have this capability, you'd be able to exit from your program and examine system status, but you'd be unable to continue program execution from the exit point: You wouldn't be able to single-step through a program. Nor would you be able to modify the system state and watch the effects of those modifications on program execution.

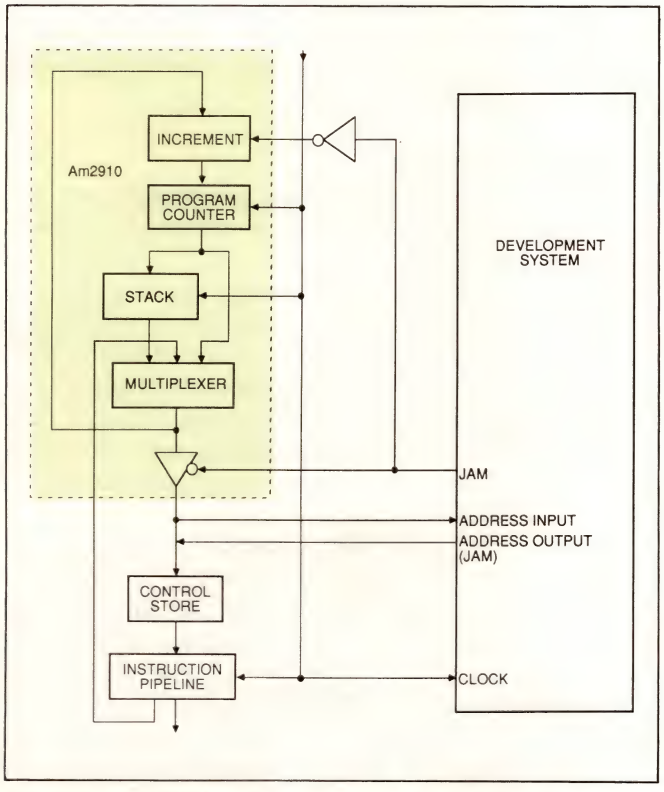

Fig 1—An Am2910-based microprogram system *can be controlled and monitored by a development system configured as shown here.*

To provide the monitor with this return capability, you need to save the address of the instruction that would have been executed next if not for the branch to the monitor. You can either save this return address in the sequencer stack, or you can capture it in a hardware register. The easiest way is to save it in the sequencer stack. This method also allows you to save the address in real time. If you resort to external circuitry to save the address, you free up the sequencer stack, but the delays associated with your circuitry may prevent you from storing or retrieving the address without stopping the system.

The microprogrammed system of **Fig 1,** which uses an Am2910 sequencer, probes the address at the output of the sequencer. The Jam line of the development system connects to the address output-enable pin of the sequencer and through an inverter to the increment-enable pin of the sequencer. During a jam cycle, the Jam line disables the output of the Am2910 and prevents the program counter from being incremented. Consequently, the address that was going to be executed next remains in the program counter during the next cycle and is available to the monitor.

In order to save this address, the first instruction of the monitor must push the program-counter value into the sequencer stack. This instruction must also force a branch to some point in the monitor code; you'll remember that the Am2910's program counter must be modified by some means other than the jammed address. To return from the monitor, you must jam the address of

TABLE 1—Am2910's REGISTER CONTENTS

ENTERING MONITOR:

PC	ADDR IN	INSTR PIPE	INC	STACK	COMMENTS
a	a		1		
b	f	a	1		;branch f
g	jam A	f	0		;branch n
n	B	A	1		;branch B, push pc
C	B	B	1	n	;branch B

LEAVING MONITOR:

PC	ADDR IN	INSTR PIPE	INC	STACK	COMMENTS
C	B	B	1	n	;branch B
C	jam C	B	0	n	;branch B
C	n	C	1	n	;branch stack, pop
o	x	n	1		;branch x

an instruction that branches to the return address, which you've saved in the sequencer stack or in your external circuitry.

Table 1 shows the sequence that the program follows when you enter and exit from the monitor. The development system is configured to jam address "A" for one instruction cycle after address "f." Note that "n," the address after "f," is pushed into the stack. When you leave the monitor, address "C" must be jammed.

Fig 2's microprogrammed design uses an AS890 sequencer. The development system once again probes the address at the output of the sequencer. The development system's Jam line connects to the AS890 address output-enable pin and uses this connection to disable output from the sequencer. The address that would have been presented on the bus is stored in the AS890's interrupt register and is available to the monitor.

For a system using the AS890, the first instruction of the monitor must push the value of the sequencer's interrupt register into the stack, thus saving the monitor return address. You enter the monitor simply by jamming the address of the first monitor instruction onto the address bus; the AS890 updates its program counter from this bus. To exit from the monitor, you must jam the address of an instruction that branches to the return address value, which you've saved in the stack. The state diagram of **Table 2** outlines this sequence of events.

TABLE 2—AS890's REGISTER CONTENTS

ENTERING MONITOR:

PC	ADDR IN	INSTR PIPE	INC	STACK	COMMENTS
a	a				
b	f	a	1		;branch f
g	jam A	f	0		;branch n
B	B	A	1		;push interrupt
C	B	B	1	n	;branch B

LEAVING MONITOR:

PC	ADDR IN	INSTR PIPE	INC	STACK	COMMENTS
C	B	B	1	n	;branch B
C	jam C	B	0	n	;branch B
C	n	C	1	n	;branch stack, pop
o	x	n	1		;branch x

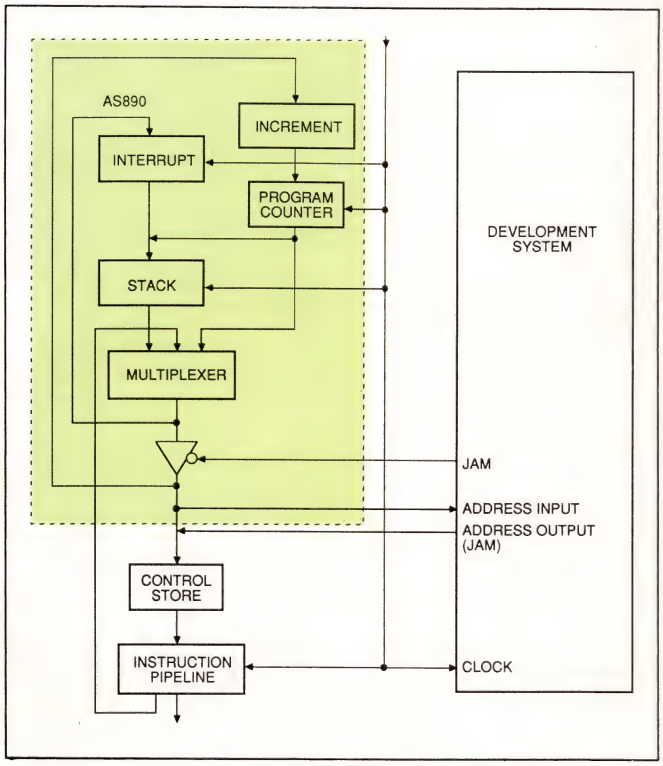

***Fig 2—In this schematic of a development system connected** to an AS890-based target system, the separate input that's usually required to prevent an increment during a jam cycle is unnecessary.*

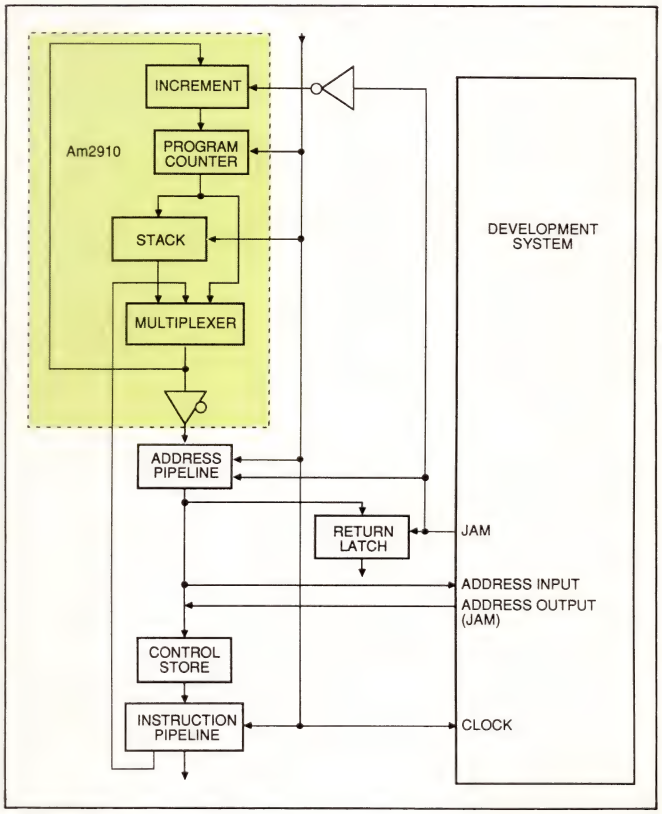

***Fig 3—A double-pipelined system presents** additional problems to the monitor developer.*

During a jam cycle, the Jam line disables the output of the 2910 and prevents the program counter from being incremented.

Although these two microprogram systems are relatively straightforward, if you have a double-pipelined system (both the address and the instructions are pipelined), additional complications may arise. Not only must the correct address be jammed onto the address line, but the address pipeline must be reloaded as well. Typically a hardware register is necessary, in addition to two stack resources, to save the required return values.

The system in **Fig 3** uses an Am2910 in a double-pipelined architecture. The microprogram development system probes the address line downstream from the address pipeline. The development system's Jam line connects to the address-pipeline output-enable pin and through an inverter to the increment-enable pin of the Am2910. As in the previous Am2910 example, this connection allows you to use the development system to disable the address output from the sequencer and to prevent the sequencer's program counter from incrementing. Because one address is already in the address pipeline, the address that's retained in the sequencer's program counter is the address of the second instruction that would be executed if the Jam line wasn't asserted.

You must use a return register to capture the address of the first instruction, which is in the address pipeline. The return register must connect to the microprogram address lines so that the address can be stored in the register prior to the assertion of the Jam line. The development system's state analyzer can read the contents of the return register, which in turn can pass the address through the writable control store to the monitor program.

The first instruction executed en route to the monitor must push the program counter into the stack and branch off to the monitor entry point. To enter the

TABLE 3—REGISTER CONTENTS OF A DOUBLE-PIPELINED SYSTEM

ENTERING MONITOR:

PC	MUX	ADDR IN	INSTR PIPE	INC	STACK	RETURN	COMMENTS
a	a			1			;cont
b	b	a		1			;cont
c	f	b	a	1			;branch f
g	n	jam A	b	0		f	;branch n
n	B	jam A	A	0		f	;branch B, push pc
B	B	B	A	1	n	f	;branch B, push pc
C	C	B	B	1	B	f	;cont
D	D	C	B	1	B	f	;cont
E	D	D	C	1	B	f	;branch D, pop
E	D	D	D	1	n	f	;branch D

PUSH RETURN ON STACK:

PC	MUX	ADDR IN	INSTR PIPE	INC	STACK	RETURN	COMMENTS
E	D	D	D	1	n	f	
E	D	jam E	D	0	n		;branch D
D	F	jam E	E	0	n		;branch F
F	F	F	E	1	n		;branch F
G	G	F	F	1	n		;cont
H	H	G	F	1	n		;cont
I	f	jam A	G	0	n		;branch f
f	B	jam A	A	0	n		;branch B, push pc
B	B	B	A	1	f		;branch B, push pc
C	C	B	B	1	B		;cont
D	D	C	B	1	B		;cont
E	D	D	C	1	B		;branch D, pop
E	D	D	D	1	f		;branch D

LEAVING MONITOR:

PC	MUX	ADDR IN	INSTR PIPE	INC	STACK	RETURN	COMMENTS
E	D	D	D	1	f		
E	D	jam H	D	0	f		;branch D
D	f	jam H	H	0	f		;branch to stack, pop
f	n	f	H	1	n		;branch to stack, pop
o	x	n	f	1			;branch x
y	y	x	n	1			;cont

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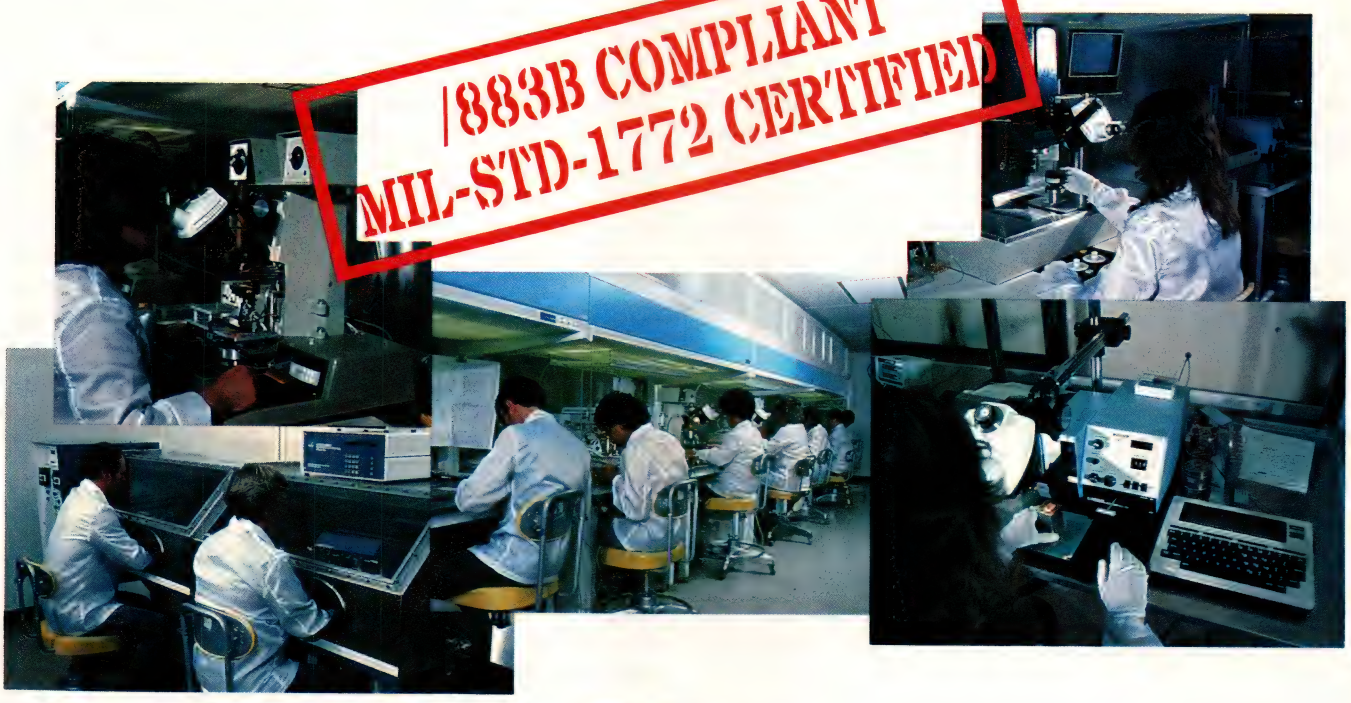

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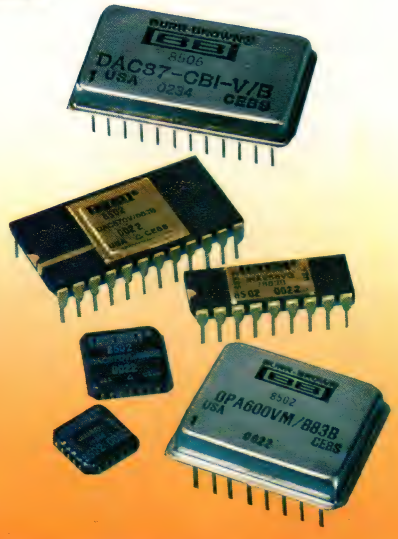

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The ability of the monitor to return to its point of departure within the microcode is essential.

monitor, you must jam the first monitor instruction twice (**Table 3**). This action fills the address pipeline with the monitor address. Because the first instruction is a branch instruction, the address of the next instruction to be executed (the return address plus one) will be pushed into the stack. When the first monitor instruction address is jammed a second time (to fill the pipeline), a useless address will be pushed into the stack. Because you use the stack to return from the monitor, you must pop the stack once to remove this garbage address.

To exit from the monitor, you must push the contents of the return register into the stack. Executing a branch to the location contained in the return register while jamming to the monitor again forces the address to be put on the top of the stack. The pipeline value is then on top of the stack and the return address is just below it. You restore the pipeline and pick up execution of the program where you left off by jamming the address of a "branch to stack, pop" instruction. Three stack locations are required for this operation.

System restoral is crucial

Of course, when you use a monitor you need to do more than simply enter and exit from the correct addresses. You must restore the target system to the exact state that it was in before you entered the monitor. It isn't difficult to accomplish this restoration with registers and memory, but flags and status information can be more difficult.

The most straightforward approach is to save the system state before entering the monitor. The disadvantage is that additional external circuitry may be necessary. However, if you write your monitor code so that you store status information in macro memory before modifying any registers, or if you refrain from using instructions that modify status registers, extra circuitry is unnecessary.

A monitor allows you to examine and modify the system state, to display memory and register contents, and to modify those contents. It also enables you to single-step through your program. Usually these functions are invoked through the use of command files on the development system, but the monitor routines are run on the target machine. Parameters pass to the monitor routines through the writable control store, and system status is gathered by the development system's state analyzer.

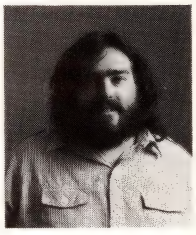
The monitor-code routines consist of a monitor-entry, main-loop, and monitor-exit routine. In addition to these code routines, you must implement routines for examining and modifying the contents of the memory and registers. In order to use file symbols in your monitor without switching database files, you need to link your monitor code to your application code.

Monitor functions are invoked by jamming the starting address of the selected function. Each function must return control to the main loop at its completion. The main loop consists of a branch to itself; the monitor idles until a jam to the start of a routine or a jam to the application code.

If you write the monitor's display functions so that the data you're interested in appears on a bus that's probed by the logic-state analyzer, the analyzer can capture and display the data for you. You can use a constant field in the microword to pass parameters to the monitor routines that modify system states. The data passes to the program via a development-system command file before the program is executed. **EDN**

Author's biography

Brian Richardson is a development engineer at the Logic Systems Div of Hewlett-Packard in Colorado Springs, CO. Brian received his BS in electrical and computer engineering from the University of Wisconsin-Madison. He likes to build stereos and play shuffleboard in his spare time.



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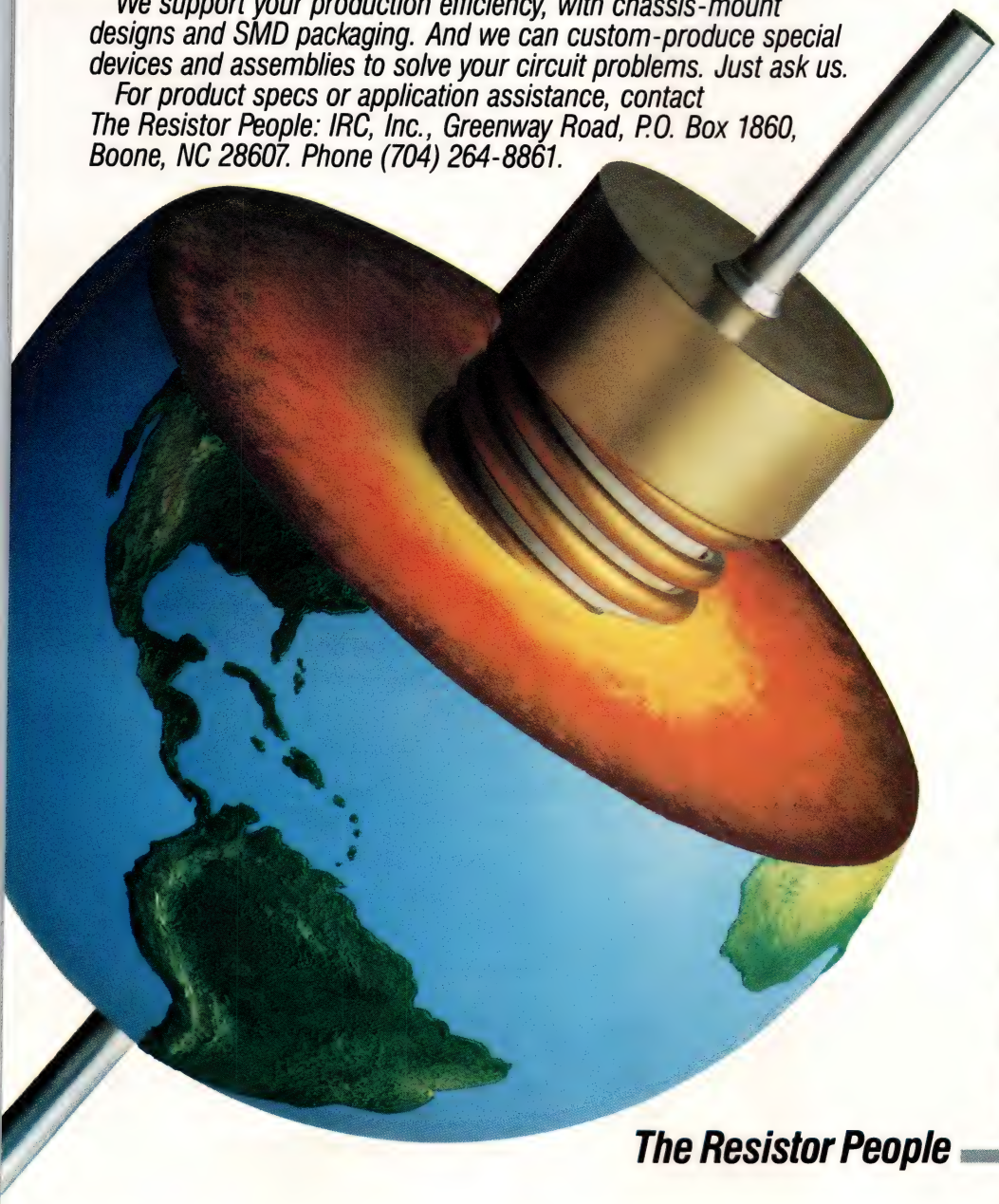

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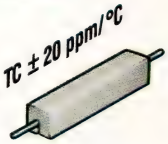

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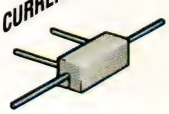

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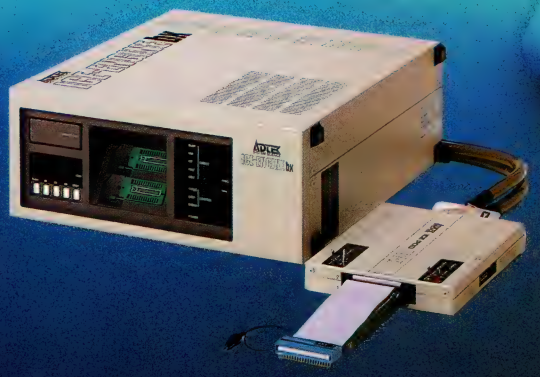

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Run-length-limited coding increases disk-drive capacity

Encoding schemes that give disk drives a high data-transfer rate prove to be a more cost-effective means of increasing storage capacity than adding extra platters and heads. Drives that incorporate such schemes and a high-quality read/write channel can increase their capacity by as much as 50%.

Bob Cloke, *Priam Corp*

The current trend toward multiuser computer systems is pressuring disk-storage manufacturers to pack more data into every disk form factor without sacrificing drive performance. These systems demand more frequent, faster access to data and increasing amounts of storage, and unless technological improvements are forthcoming, you'll generally trade increased storage capacity for data reliability. You can balance the trade-off between capacity and reliability by selecting a suitable encoding scheme like the run-length-limited (RLL) (2,7) code, and by designing other aspects of the drive with care.

Increasing the amount of data stored on any given medium requires a combination of well-designed read/write-channel electronics and data-encoding schemes that can take the maximum advantage of the flux changes on that medium. Data is stored as a stream of simple non-return-to-zero (NRZ) pulses; each pulse requires a flux change on the disk surface and represents a potential data bit. The higher the drive's linear storage density, measured in flux changes per inch along each track, the more data a disk medium can store.

Encoding and formatting are essential

No simple translation from a drive's linear storage density to a disk medium's storage capacity is possible, however. Data, of course, must be encoded to be understandable, and it must be formatted so that it can be easily located; yet the track-format overhead and the particular data-encoding scheme used will vary from drive to drive.

Before you consider the other design factors, you must first understand how an encoding scheme affects storage capacity. A measure of the effectiveness of a particular encoding scheme used to store data on the disk is its recording density. If the closest spacing between transitions on the disk is one bit cell (a bit cell contains exactly one data bit), the encoding scheme has a recording density of 1.0. The maximum storage capacity is then the same as the drive's formatted capacity; the scheme will store data bits at the maximum flux-change rate made available by the drive's sector format.

Modified frequency modulation (MFM) is an example of an encoding scheme with a recording density of 1.0. By comparison, a simpler approach is frequency modulation (FM), which stores a clock bit and a data bit in

Until recently, MFM has been the standard encoding scheme for 5¼-in. Winchester drives, but the emphasis on cost per megabyte is forcing a change.

pairs within each cell. Its recording density is therefore 0.5.

MFM is the best known example of a class of the self-clocking encoding schemes called run-length-limited (RLL) codes. Another example is group-coded recording (GCR), a scheme used frequently for magnetic-tape recording. These schemes embed sufficient clocking information into the coded data to ensure that data is read accurately. Thus, they increase the capacity of the disk over other approaches, which actually insert clock pulses into the data stream.

Although until recently MFM has been the standard encoding scheme for 5¼-in. Winchester drives, the emphasis on cost per megabyte is forcing a change. More sophisticated encoding schemes offer higher recording densities than that offered by MFM. Manufacturers of high-capacity disk drives are therefore turning to an RLL code known as the (2,7) scheme. Codes of this general class are not new, however. A (2,11) code was used in 14-in. disks as early as 1976, and IBM Corp introduced its version of the (2,7) code in its 3370 family of disk drives about 1979.

The surge in popularity of the (2,7) code is due to its high recording density and the recent, pressing need for such capacity. The (2,7) code offers a recording density of 1.5; that is, you can—theoretically, at least—increase the capacity of a drive by 50% simply by switching from MFM to (2,7) coding. This improvement is only theoretical because the use of high-density coding schemes exacts some design penalties that can make the actual increase less dramatic. To achieve a capacity that approaches a 50% increase, you must make some changes in your system components, as well as in your encoding scheme.

Choosing the appropriate RLL code

Each type of storage application has different coding needs; no one coding scheme is ideal in every case, and RLL codes are certainly not all alike. To see how these codes differ, you should examine their construction. A standard set of parameters that describes every RLL scheme conveys that construction.

The first parameter, known as the d parameter, describes the minimum number of zeros that will come between ones in the code stream. These zeros are inserted to reduce the potential for read errors caused by pulse crowding, or intersymbol interference.

The k parameter defines the maximum number of consecutive zeros that can appear in a message. These first two parameters, d and k, are the ones most often

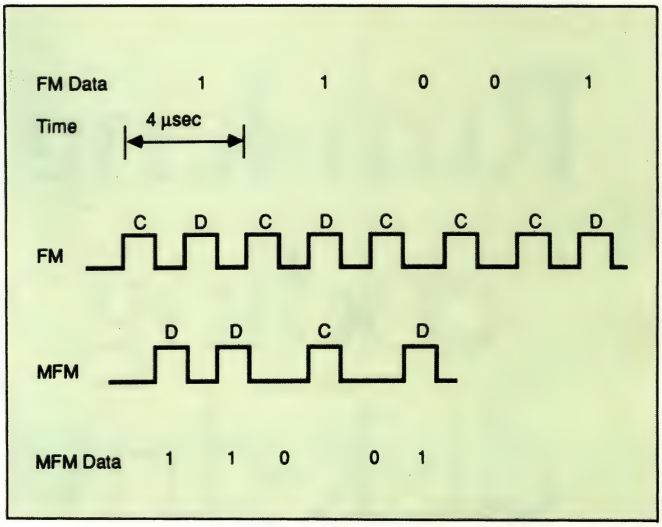


Fig 1—An MFM-encoded bit cell holds no more than a single pulse and can be half the length of an FM-encoded bit cell.

used in the shorthand identification of a code. For example, in FM coding, a clock pulse precedes every data pulse, and the shorthand for the code would therefore be (0,1). The only possible messages in FM are "1 1", which represents a "one" data bit, and "1 0", which represents a "zero" data bit. The code stream can therefore have consecutive ones (d=0), but because every other pulse is a clock pulse (a one), the message can't possibly contain more than one consecutive zero (k=1).

Rate a function of code and data blocks

The m and n parameters define the number of bits in the data block and the number of bits in the code block, respectively. Dividing the data-block size (m) by the code-block size (n) gives you the code rate.

The last parameter is the r parameter, which tells you the number of different code-word lengths possible in the scheme. The resulting description convention for the various RLL codes has the format (d,k,m,n,r).

To better understand how these parameters describe a code, examine a simple RLL code, such as MFM. Each bit cell of an MFM-coded message contains at most a single pulse. Consequently, the bit cell can be half the length of a 2-pulse FM-coded message (**Fig 1**). The convention calls for all data bits to be written in the middle of the cell: If there is a transition in the middle of the cell, the code represents a data one; if there is no transition, the code represents a data zero.

To keep the drive from losing count in any long string of zeros, whenever the data stream contains any two

consecutive zeros, the drive's controller adds a one at the common boundary of the bit cells as a clock signal. Consequently, when it reads the data back, the controller can distinguish between a clock pulse or a data pulse by its position in the bit cell.

Code lengths vary for (2,7)

Now consider the parameters for MFM coding. Every pair of ones is separated by at least one zero; therefore, d=1. There are never more than three consecutive zeros (k=3). The shorthand description for this RLL code is therefore (1,3).

The full description of the RLL (2,7) code is (2,7,1,2,3). Besides the recording density ((m/n)(d+1)=1.5), one major difference between (2,7) and MFM coding is that the lengths of (2,7) code streams vary. MFM code streams are always two bits long, while (2,7) code streams come in three different lengths —four, six, or eight bits:

DATA	CODE
0 0 0	0 0 0 1 0 0
1 0	0 1 0 0
0 1 0	1 0 0 1 0 0
0 0 1 0	0 0 1 0 0 1 0 0
1 1	1 0 0 0
0 1 1	0 0 1 0 0 0
0 0 1 1	0 0 0 0 1 0 0 0

Now consider an example of the effect that changing the data format can have on the storage capacity of an actual drive. Priam Corp's V185 5¼-in. Winchester disk drive features an unformatted capacity of 85M bytes and a formatted capacity of 71M bytes. Consequently, 14M bytes are consumed by format overhead, such as sector and track ID, cyclic redundancy checking (CRC), and other information, as shown in the sector-format chart (**Fig 2**). The 71M-byte block represents the maximum storage capacity that the drive offers when using a standard ST-412/506 controller, the format shown, and MFM encoding. Keep in mind that this controller can handle a 5M-bps maximum data-transfer rate.

The data-transfer rate for a disk drive is the product of the disk rotation (rpm/60) and the drive's unformatted track capacity. In the case of the V185, the rotational speed is 3600 rpm. Using MFM's recording density of 1.0, the track capacity is 10,416 bytes (83,328 bits). With MFM, therefore, the data-transfer rate is 5M bps. Using the (2,7) code and its recording density of 1.5, the unformatted capacity is 15,624 bytes (124,992 bits); the appropriate calculation yields a data-transfer rate of 7.5M bps.

This interrelationship between data-transfer rate and the linear density underlines the advantage—and one difficulty—of moving to more densely coded formats. The advantage, of course, is increased data capacity, but the designer will have to suffer the

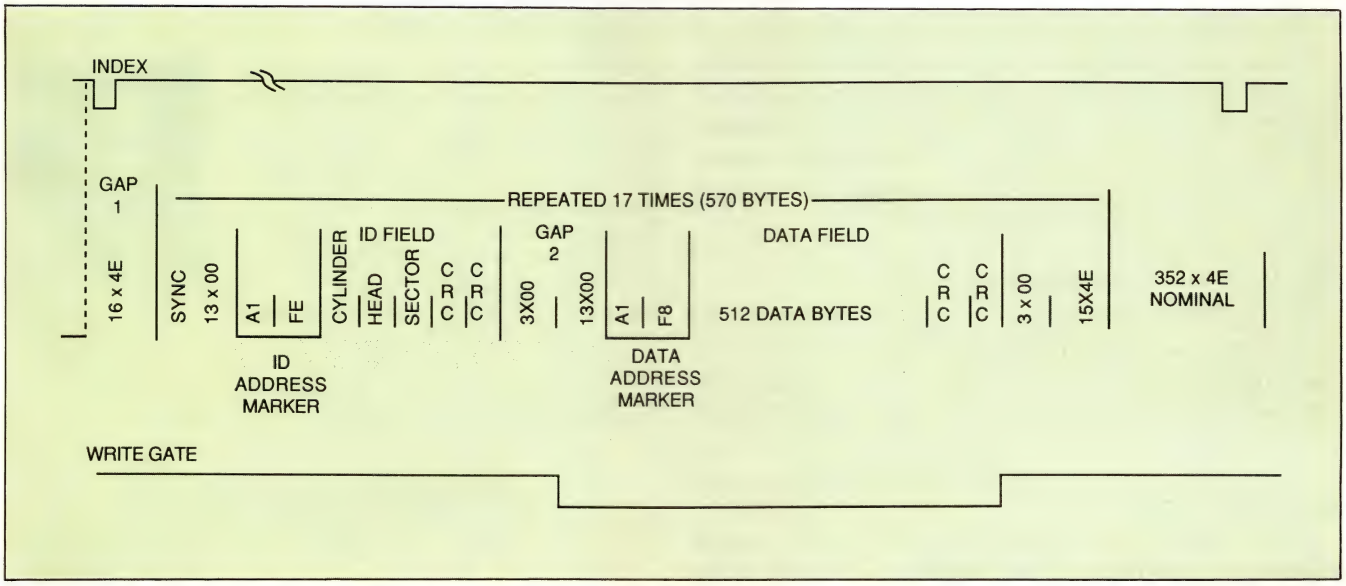


Fig 2—The format of the track and sector *in the V185 drive devotes 14M bytes of the drive's potential capacity to overhead. The format reserves 71M bytes for data, assuming the use of MFM encoding and a controller that can handle a 5M-bps data-transfer rate.*

Manufacturers of high-capacity disk drives are turning to an RLL code known as the (2,7) code.

expense of a more capable controller. Configuring the same V185 drive with a high-performance controller, such as an Adaptec 4070B, which implements the (2,7) encoding scheme, takes advantage of the 7.5M-bps data-transfer rate (and the high recording density) to store 107M bytes on the same drive—an increase, by a factor of approximately 50%, of 36M bytes.

Of course, nothing is free. If you increase your drive's storage density, you'll not only have to ensure that other components of your design can handle the data-transfer rate; you'll also have to pay special attention to data-reliability problems that arise whenever the data-transfer rate increases.

The problem is bandwidth. Although you can increase the data-transfer rate simply by changing to the (2,7) code, the data separator now has far less time available in which to decide whether a pulse represents a clock bit or a data bit. In an MFM implementation with the data arriving at 5M bps, the data (or clock) pulses have a minimum spacing of 200 nsec. During this time the data separator must make two decisions, each within a 100-nsec period. The data separator, therefore, has a detection window of ±50 nsec.

Using the 7.5M-bps RLL (2,7) code, the same number of flux changes requires the data separator to make three decisions, each within a 67-nsec period, for a detection window of ±33 nsec. As the detection window narrows, the window margin rapidly decreases, and the data separator's tolerance for bit shift or interference from noise is far lower.

Furthermore, as the frequency ratio ((k+1)/(d+1)) increases, the readback waveforms exhibit substantially more shouldering (the tendency of a signal to remain near the base line for a period of time). This phenomenon can strain the capability of a read/write channel and requires detectors that don't respond to the noise that can come between data peaks.

Attend to the read/write channel

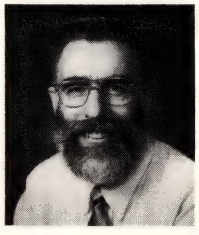
The key to making the (2,7) coding scheme work lies in designing a high-quality read/write channel—the combination of the head/medium interface, preamplifiers, and detection circuitry. The wider the bandwidth of the read/write channel, and the higher its tolerance to noise, the fewer the problems introduced by high-speed data transfer.

The V185 disk drive uses thin-film media, which support a much higher linear recording density, without pulse crowding, than do oxide media. The thin-film medium is quieter, reducing errors introduced by noise. It achieves the same level of reliability and accuracy in spite of the shorter detection windows and the faster data-transfer rate. And the cost per megabyte is lower with the thin-film drive than with an equivalent oxide-medium drive, because the capacity is gained through the encoding scheme rather than by adding platters and heads.

The electronics of the V185 were designed with (2,7) coding in mind; it's somewhat overdesigned for applications that employ MFM. Yet upgrading other drives may not be as simple as choosing a drive that's already tailored to (2,7) encoding. In fact, as a rule of thumb, you can expect a drive that's at its maximum linear density with MFM to accommodate a typical capacity increase of about 30% by moving to (2,7) encoding. Pushing the technology of the head/medium interface any further would decrease data reliability, primarily by magnifying the effects of pulse crowding and noise-induced peak shifts relative to the new window size, which is now smaller because of the higher data rate. Still, a 30% increase in capacity obtained from a simple exchange of encoding schemes would be welcome.

The use of high-density RLL codes provides a cost-effective tool for increasing the capacity of high-performance 5¼-in. Winchester drives. As the read channel becomes more sophisticated and components improve, the same form factors will afford designers even more capacity. **EDN**

Author's biography



Bob Cloke is a key technologist with Priam Corp (San Jose, CA). He has more than 15 years of experience in the disk-drive industry. Before joining Priam in 1983, he held various engineering and management positions at the former Information Storage Systems. He has bachelor's degrees in electrical engineering and physics from California State Polytechnic University (San Luis Obispo) and an MSEE from the University of California at Berkeley. He holds nine patents related to magnetic recording.

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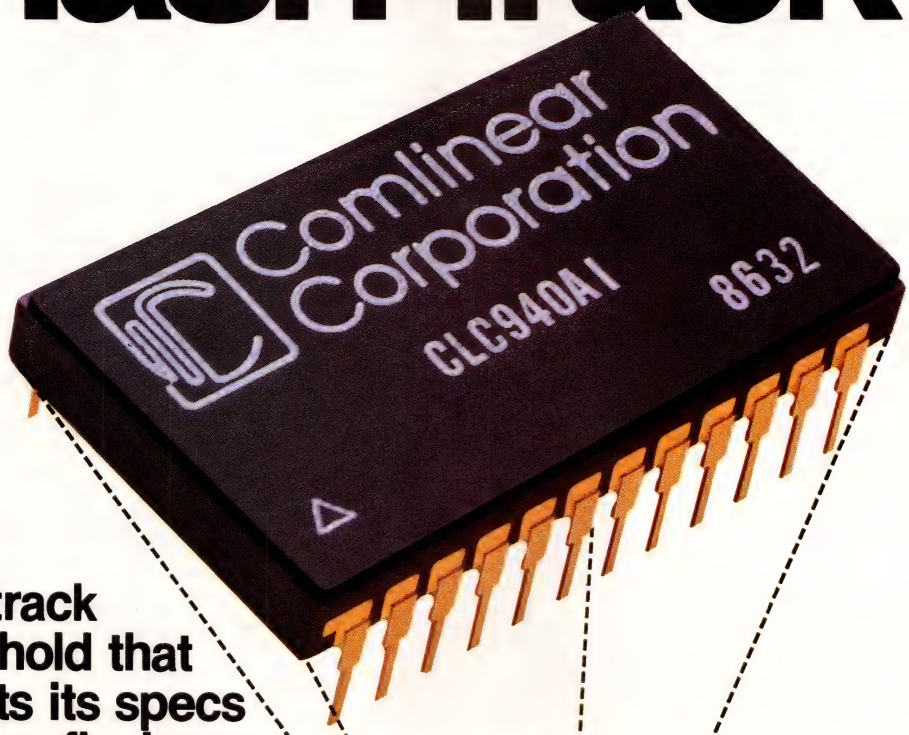

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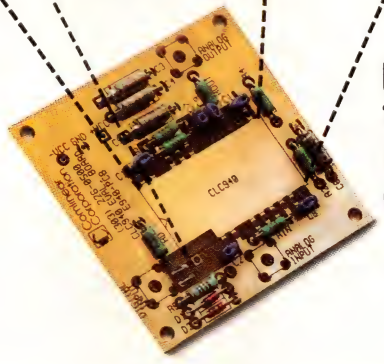

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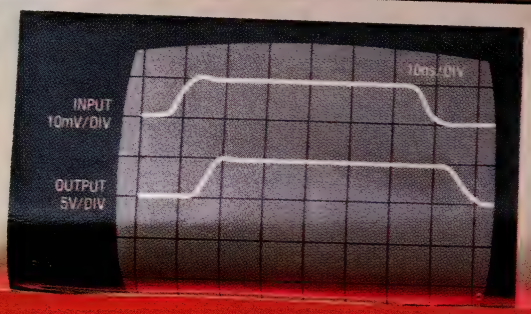

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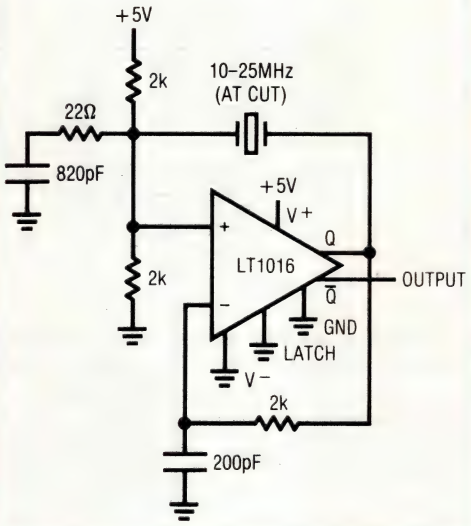

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To monitor an automobile alternator's output current, for example, connect the car's battery between the circuit's V_B terminal and ground, and wrap one turn of wire through the toroid. (Or, you could wrap 40 turns—if they'd fit—to measure 1A full scale.) When I=0V, the current sensor's (CS_1's) V_H output equals one-half of its 10V bias voltage. Because regulators IC_1 and IC_2 provide a bipolar bias voltage, V_H and V_{OUT} are zero when I is zero; you can then adjust the output gain and offset to scale V_{OUT} at 1V per 10A. **EDN**

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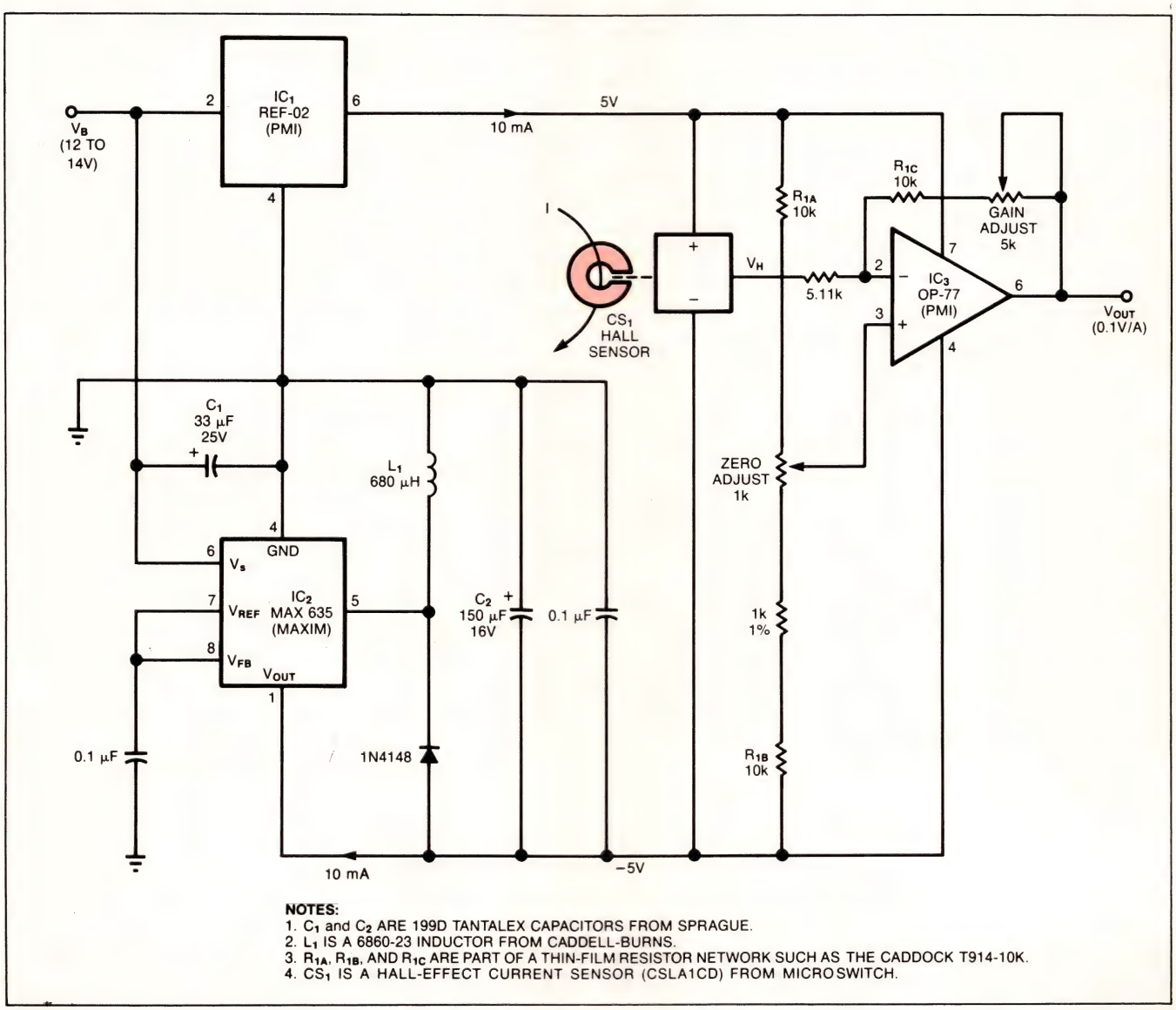

NOTES:
1. C_1 and C_2 ARE 199D TANTALEX CAPACITORS FROM SPRAGUE.
2. L_1 IS A 6860-23 INDUCTOR FROM CADDELL-BURNS.
3. R_{1A}, R_{1B}, AND R_{1C} ARE PART OF A THIN-FILM RESISTOR NETWORK SUCH AS THE CADDOCK T914-10K.
4. CS_1 IS A HALL-EFFECT CURRENT SENSOR (CSLA1CD) FROM MICROSWITCH.

Fig 1—This circuit's Hall-effect current sensor CS_1 enables V_{OUT} to register dc current at 1V per 10A.

Build passive, RC-ladder filters

Mark Rumreich
RCA Corp, Indianapolis, IN

For passive-filter applications in which inductors are unacceptable, ladder filters based on resistors and capacitors can be the best choice. Pole ratios serve as a figure of merit for these filter types: For a given −3-dB frequency, the closer the poles the better the rejection. Coincident poles, however, can occur only if there is no interaction—that is, if the impedance of each stage (pole network) is much higher than that of the preceding stage.

Because these passive filters can realize only real poles, they generally offer less rejection than complex-pole filters such as Chebyshev or Butterworth. The graphs of **Fig 1** and **Fig 2** compare Butterworth responses with that of ladder filters of various pole ratios (P). (For the third-order case, P indicates the ratio of the highest-to-middle pole as well as that of the middle-to-lowest pole.)

Notice that passband characteristics of the RC filters are similar to those of the first-order Butterworth filters, regardless of order or pole ratio. The gain slope for all filters of a given order approaches −20 dB per decade per pole at high frequency; for $\omega<10$, the third-order RC response is comparable to that of the second-order Butterworth.

The procedure for designing these RC-ladder filters assumes that a voltage source drives the filter and that the filter operates in an open circuit. Consequently, you should subtract the resistance of the source from the input resistor and consider the load to be in parallel with the output resistor. To synthesize a filter, first determine the filter's largest tolerable ratio of output to input resistance (K for the second-order case and K^2 for the third-order case). Select normalized component values from **Table 1** or **Table 2,** and convert these to the desired values using frequency and impedance transformations.

To convert the normalized components to more practical and convenient values, multiply the resistor values by a desired constant and divide the capacitor values by the same constant. Similarly, you can transform the −3-dB frequency to the reqired value (f) by dividing the capacitor (and inductor) values by $2\pi f$; resistor values don't change.

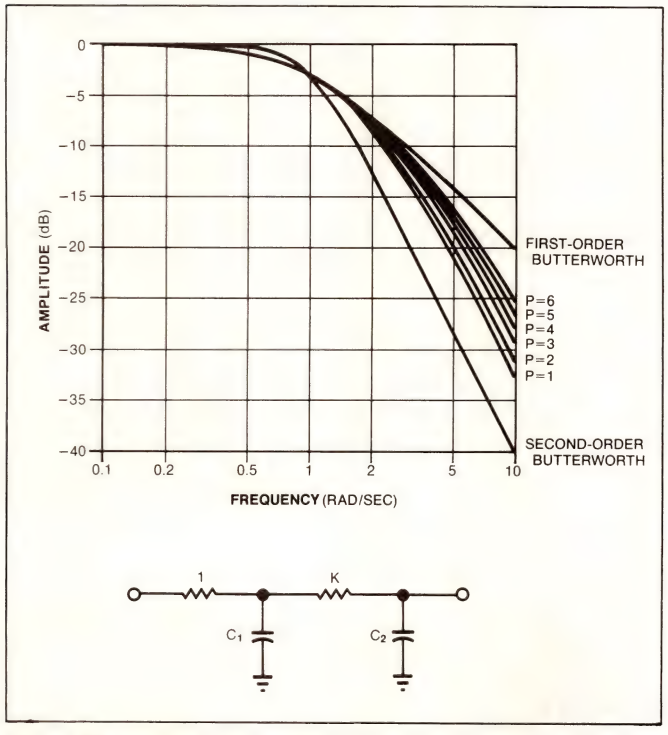

***Fig 1—These curves show the frequency-vs-magnitude** response for second-order RC-ladder filters of various pole ratios (P). Note that these responses fall between those of a first- and second-order Butterworth filter.*

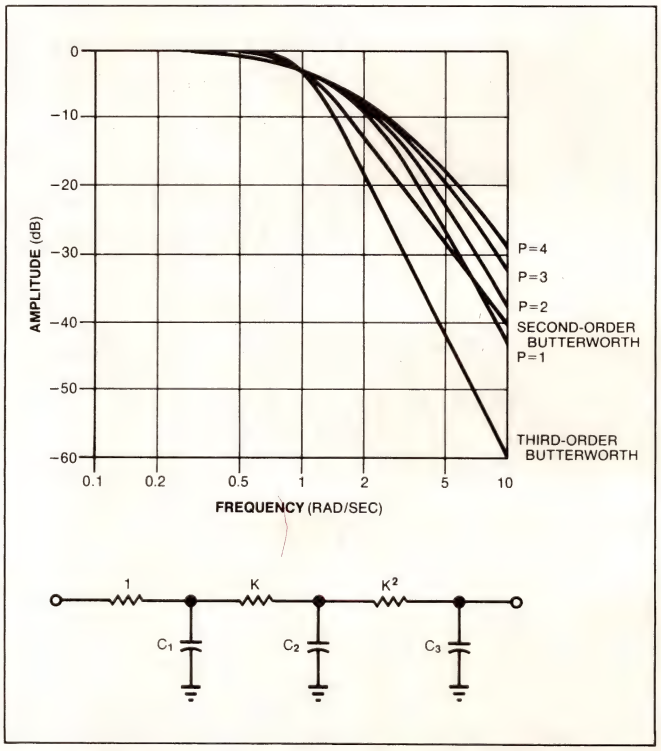

***Fig 2—These curves show the frequency-vs-magnitude** response for third-order RC-ladder filters of various pole ratios (P). Second- and third-order Butterworth responses are included for comparison.*

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HIGH PASS Model *HP-		50	100	150	200	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	290	395	500	600	700	780	910	1000
	end, min.	200	400	600	800	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)		26	55	95	116	190	290	365	460	520	570	660	720

Prices (ea.): P $12.95 (6-49), B $27.95 (1-49), N $30.95 (1-49), S $29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA *example:* **PLP-10.7**

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C105 REV. B

You can use **Table 1** and **Table 2** to design a highpass RC-ladder filter as well. Label the component values as shown in **Fig 3** and perform the necessary impedance and frequency translations as described above. Using these tables results in a filter (lowpass or highpass) with the lowest possible pole ratio for a given value of K. *(Ed Note: The author hasn't verified that the 1, K, K^2 sequence will produce the lowest pole ratio for a given output/input-resistor ratio.)* **EDN**

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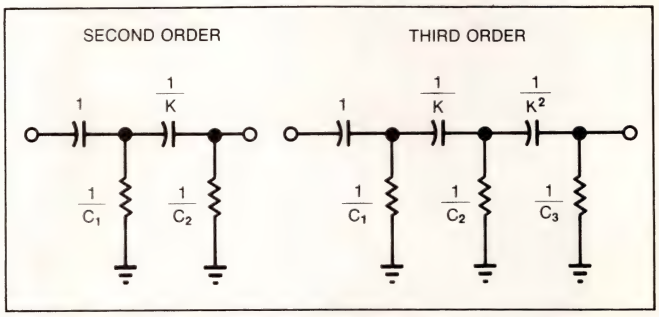

***Fig 3—These highpass-filter configurations** let you use the normalized component values of **Table 1** and **Table 2**.*

TABLE 1—SECOND-ORDER CASE

2ND ORDER COMPONENT VALUES K	C1	C2	P
1.00	0.568	0.2842	5.83
1.10	0.572	0.2724	5.45
1.20	0.575	0.2614	5.14
1.30	0.578	0.2514	4.87
1.40	0.581	0.2421	4.64
1.50	0.584	0.2334	4.44
1.60	0.586	0.2253	4.27
1.70	0.588	0.2178	4.11
1.80	0.590	0.2108	3.97
1.90	0.592	0.2041	3.85
2.00	0.594	0.1979	3.73
2.20	0.597	0.1865	3.54
2.40	0.600	0.1764	3.37
2.60	0.602	0.1672	3.23
2.80	0.605	0.1591	3.11
3.00	0.606	0.1516	3.00
3.20	0.608	0.1448	2.91
3.40	0.610	0.1386	2.82
3.60	0.611	0.1329	2.75
3.80	0.613	0.1276	2.68
4.00	0.614	0.1228	2.62
4.50	0.616	0.1121	2.49
5.00	0.619	0.1031	2.38
5.50	0.621	0.0955	2.29
6.00	0.622	0.0889	2.22
6.50	0.624	0.0832	2.15
7.00	0.625	0.0781	2.09
7.50	0.626	0.0736	2.04
8.00	0.627	0.0697	2.00
9.00	0.628	0.0628	1.92
10.00	0.630	0.0572	1.86
11.00	0.631	0.0526	1.81
12.00	0.632	0.0486	1.77
13.00	0.632	0.0452	1.73
14.00	0.633	0.0422	1.70
15.00	0.634	0.0396	1.67
16.00	0.634	0.0373	1.64
17.00	0.635	0.0353	1.62
18.00	0.635	0.0334	1.60
19.00	0.636	0.0318	1.58
20.00	0.636	0.0303	1.56
30.00	0.638	0.0206	1.44
40.00	0.639	0.0156	1.37
50.00	0.640	0.0125	1.33
60.00	0.640	0.0105	1.29
70.00	0.640	0.0090	1.27
80.00	0.641	0.0079	1.25
90.00	0.641	0.0070	1.23
100.00	0.641	0.0063	1.22

TABLE 2—THIRD-ORDER CASE

3RD ORDER COMPONENT VALUES K	C1	C2	C3	P
1.50	0.514	0.1143	0.099001	3.42
1.60	0.514	0.1130	0.091467	3.28
1.70	0.513	0.1116	0.084767	3.16
1.80	0.512	0.1101	0.079047	3.05
1.90	0.513	0.1086	0.073295	2.96
2.00	0.512	0.1071	0.068395	2.87
2.20	0.512	0.1040	0.059816	2.73
2.40	0.512	0.1009	0.052744	2.61
2.60	0.510	0.0977	0.046966	2.51
2.80	0.511	0.0948	0.041898	2.42
3.00	0.510	0.0919	0.037625	2.34
3.20	0.510	0.0892	0.033951	2.28
3.40	0.510	0.0865	0.030776	2.22
3.60	0.510	0.0840	0.028050	2.17
3.80	0.510	0.0815	0.025643	2.12
4.00	0.510	0.0792	0.023534	2.08
4.50	0.509	0.0739	0.019278	1.99
5.00	0.509	0.0692	0.016057	1.92
5.50	0.508	0.0650	0.013582	1.86
6.00	0.508	0.0613	0.011627	1.81
6.50	0.508	0.0579	0.010062	1.76
7.00	0.508	0.0549	0.008799	1.73
7.50	0.508	0.0521	0.007756	1.69
8.00	0.508	0.0497	0.006886	1.66
9.00	0.508	0.0453	0.005534	1.62
10.00	0.508	0.0417	0.004542	1.57
11.00	0.508	0.0386	0.003795	1.54
12.00	0.508	0.0359	0.003218	1.51
13.00	0.508	0.0335	0.002762	1.49
14.00	0.508	0.0315	0.002397	1.47
15.00	0.508	0.0296	0.002100	1.45
16.00	0.508	0.0280	0.001855	1.43
17.00	0.508	0.0266	0.001650	1.41
18.00	0.508	0.0253	0.001477	1.40
19.00	0.508	0.0241	0.001330	1.39
20.00	0.508	0.0230	0.001204	1.38
25.00	0.508	0.0188	0.000780	1.33
30.00	0.508	0.0158	0.000545	1.30
35.00	0.508	0.0137	0.000403	1.27
40.00	0.508	0.0121	0.000310	1.25
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CIRCLE NO 195

Improved tachometer eliminates backlash

Andrew Dart
Trans-Texas Telegraph Co, Duncanville, TX

The tachometer circuit of **Fig 1** interprets the quadrature square-wave signals from an optical encoder. This circuit performs the same function as that of an earlier Design Idea ("Bidirectional tachometer offers low error," *EDN*, October 30, 1986, pg 204), but it reduces the IC count from 11 to 3 and produces twice as many pulses per encoder revolution. It also eliminates backlash: The FWD and REV outputs indicate the direction of encoder rotation at every transition of the tachometer signals A or B, regardless of how little the encoder rotates before changing direction.

The encoder shown is a Hewlett-Packard HEDS-7500; HP recommends Schmitt-trigger buffers IC_{1A} and IC_{1D} to improve noise immunity of the tachometer signals A and B. The remaining two pairs of inverters

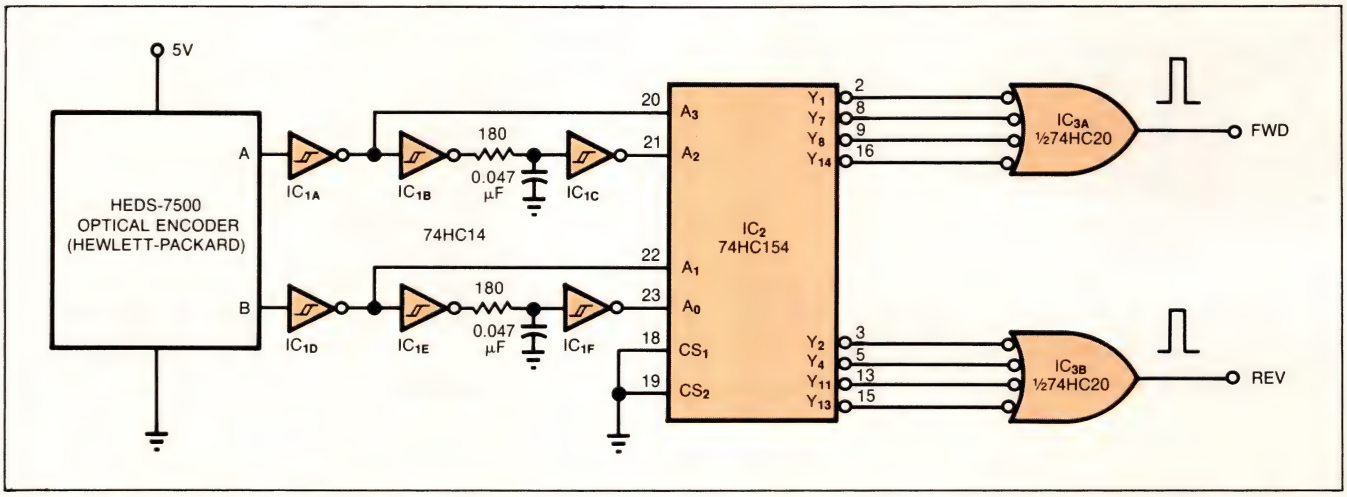

Fig 1—This 3-chip circuit transforms *the A and B tachometer signals into pulses representing forward and reverse rotation of the optical encoder's shaft.*

TABLE 1—POSSIBLE STATES OF A AND B

ENCODER SIGNALS A	B	IC_2 ADDRESS INPUTS* A3	A2	A1	A0	IC_2 OUTPUTS**	INTERPRETATION
L	L	L	L	L	L		
L	↓	L	L	L	H	Y_1	FORWARD
L	↑	L	L	H	L	Y_2	REVERSE
L	H	L	L	H	H		
↓	L	L	H	L	L	Y_4	REVERSE
↓	↓	L	H	L	H		[CAN'T HAPPEN]
↓	↑	L	H	H	L		[CAN'T HAPPEN]
↓	H	L	H	H	H	Y_7	FORWARD
↑	L	H	L	L	L	Y_8	FORWARD
↑	↓	H	L	L	H		[CAN'T HAPPEN]
↑	↑	H	L	H	L		[CAN'T HAPPEN]
↑	H	H	L	H	H	Y_{11}	REVERSE
H	L	H	H	L	L		
H	↓	H	H	L	H	Y_{13}	REVERSE
H	↑	H	H	H	L	Y_{14}	FORWARD
H	H	H	H	H	H		

L = LOW
H = HIGH
↑ = POSITIVE-GOING TRANSITION
↓ = NEGATIVE-GOING TRANSITION
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each form a 10-μsec delay line; therefore, a logic transition on either the A or B signal applies a momentary address at the input of the 4- to 16-line decoder IC_2.

In turn, the decoder asserts a momentary low on one of its output lines (**Table 1**). Each of A's and B's eight possible states involving a logic transition produces a unique address, and the corresponding outputs drive the appropriate NAND gate (IC_{3A} or IC_{3B}). During the delay interval following a transition, the state of the other tachometer signal indicates the direction of encoder rotation.

The timing diagrams of **Fig 2** show normal operation (**a**), and they show a special case (**b**) in which the encoder shaft wobbles after it stops, generating a signal on B but not on A. In most cases, the FWD and REV outputs will register even these brief changes in direction.

You can track the encoder's motion using a counter with separate up and down inputs (**Fig 3a**) or a counter with one clock input and a separate up/down control line (**3b**). For slightly more money and a slight increase in power dissipation, you can replace IC_2 and IC_3 with a small PROM. **EDN**

To Vote For This Design, Circle No 746

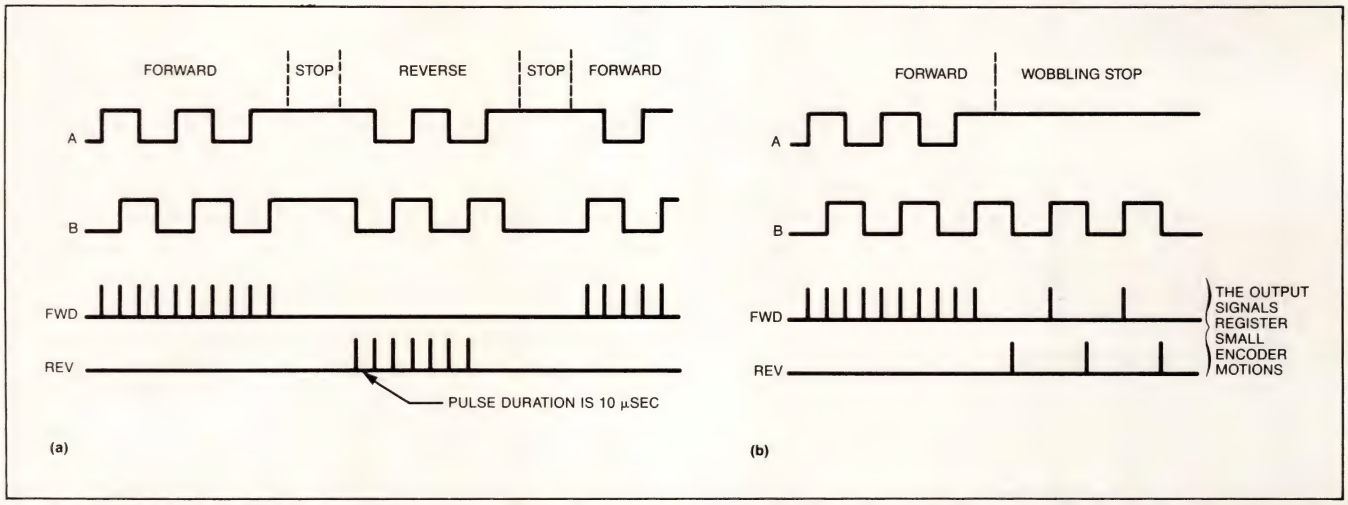

***Fig 2—These timing diagrams** illustrate normal operation **(a)** and a special case in which the encoder shaft wobbles before coming to a complete stop **(b)**.*

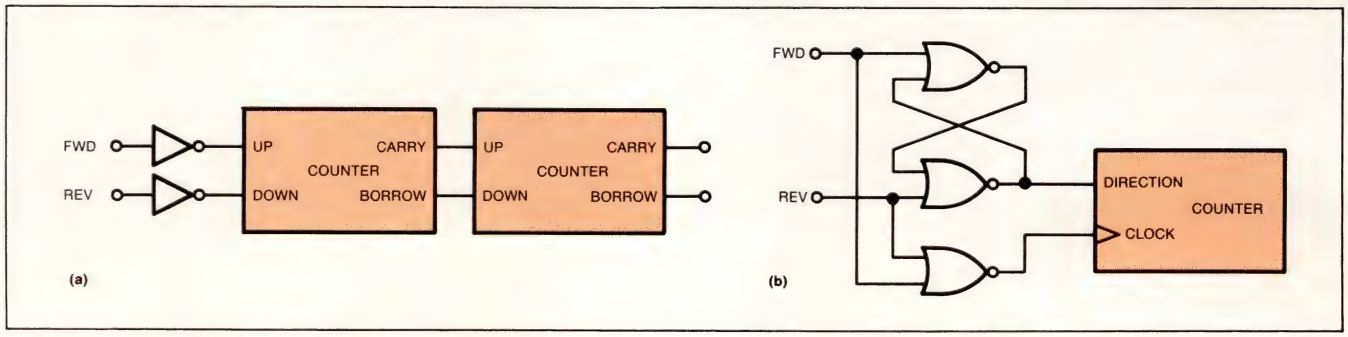

***Fig 3—To monitor the optical encoder's shaft rotation,** one circuit uses a counter with separate up/down inputs **(a)**, and the other uses a counter with a clock input and direction inputs **(b)**.*

Circuit indicates status of power supply

Bruce Tyda
Northern Telecom, Morton Grove, IL

An indicator circuit (**Fig 1**) uses LEDs to show the status of power supplied by an ac adapter and a backup battery. A steady green light indicates that ac power is okay, a flashing green indicates that ac power has failed but the battery is okay, and alternate flashes of green

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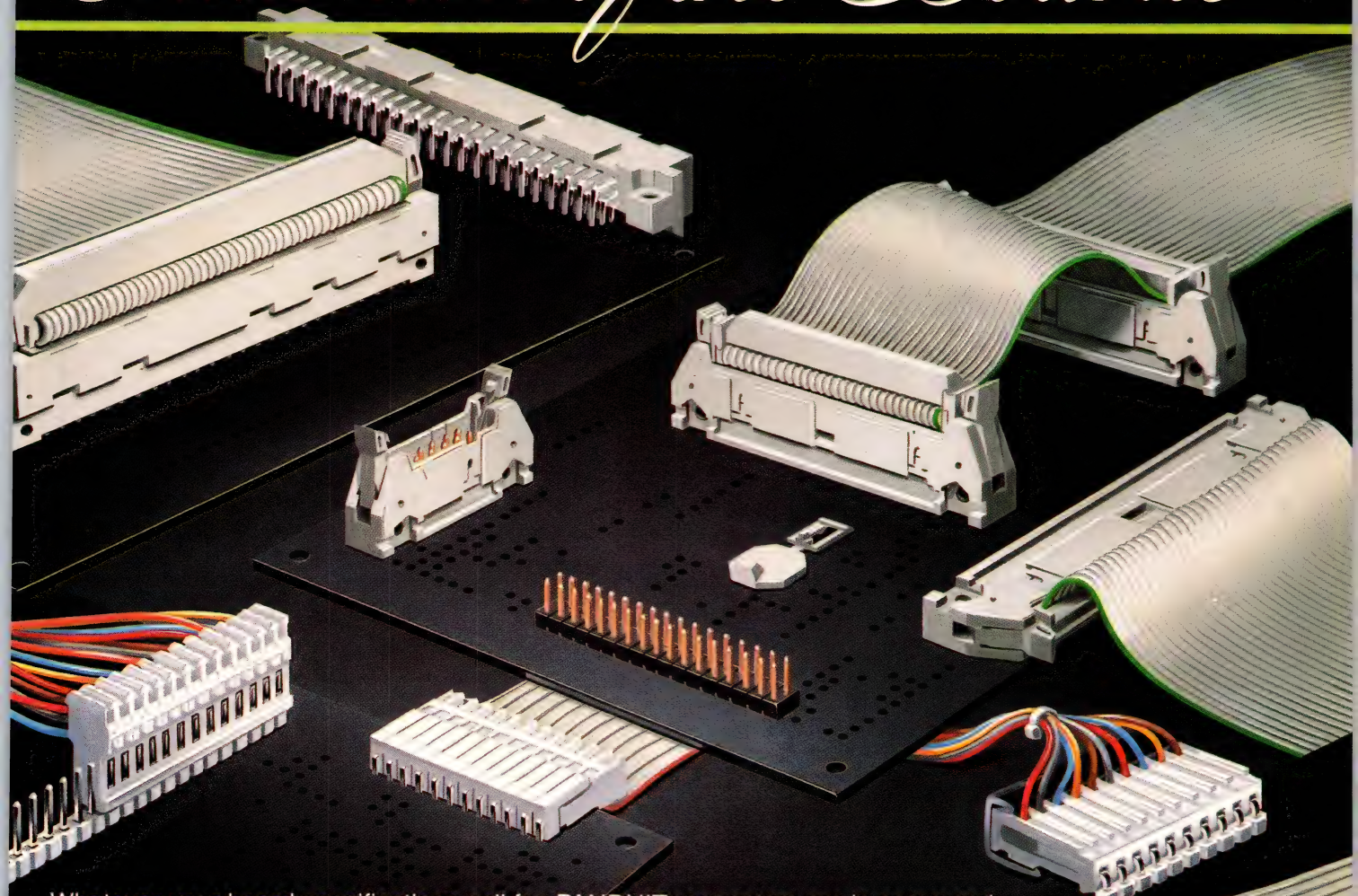

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CIRCLE NO 170

and red indicate that ac has failed and the battery is low.

When 9V from the ac adapter is present, the voltage biases the zener diode (D_1) on, which turns off Q_2 but allows Q_1 to conduct. This action turns on the green LED. Transistor Q_3 is on, shunting off the red LED.

When the ac-adapter voltage fails or drops below approximately 8V (the exact threshold depends on the zener voltage), the zener turns off, allowing Q_1 and Q_2 to operate as a low-frequency multivibrator. This action causes the green LED to flash; Q_3 continues to hold the red LED off.

Transistor Q_3 turns off when the battery voltage drops below 6.5V, allowing current to flow through the red LED. The resulting indication of low battery voltage is alternate flashes of red and green. High-efficiency LEDs give the best visual effect. **EDN**

To Vote For This Design, Circle No 748

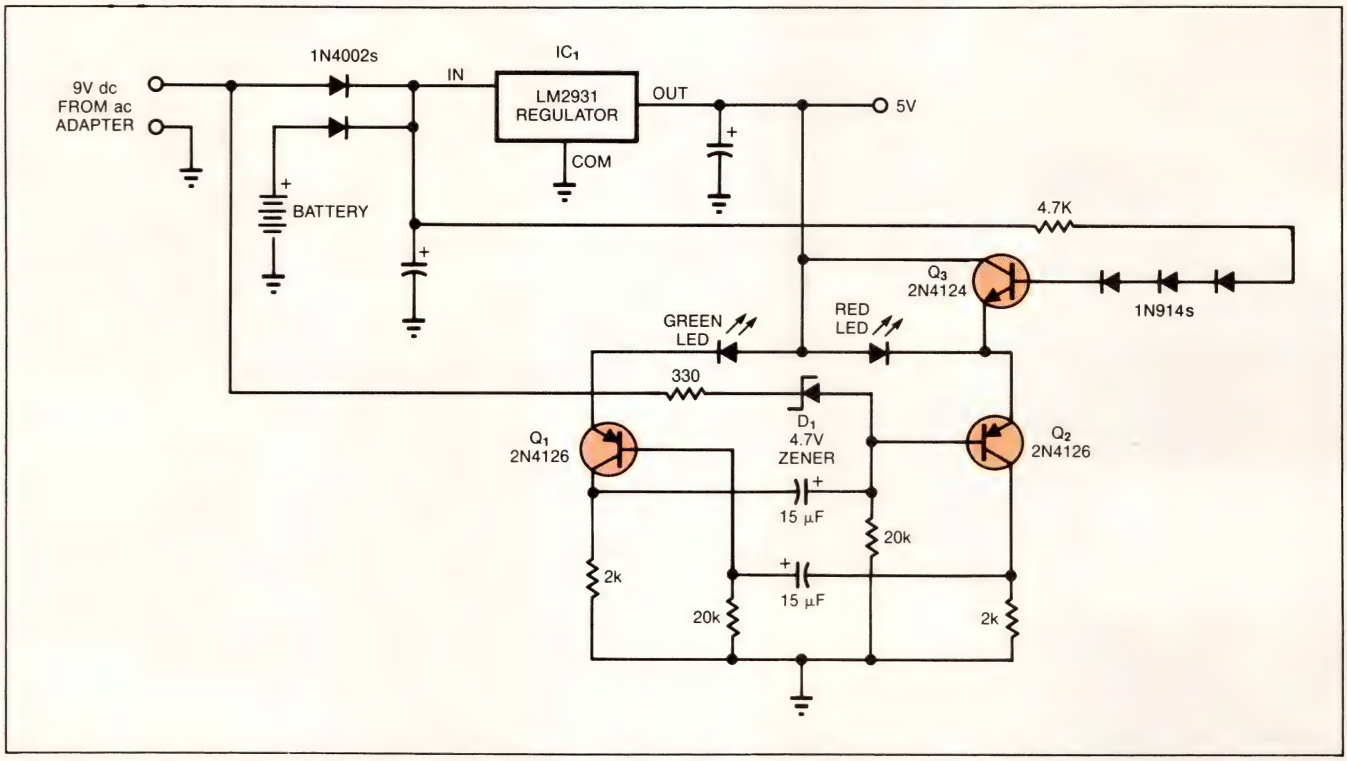

***Fig 1—This circuit's green and red LEDs** indicate three conditions: power okay, ac failed, and ac failed/battery low.*

Synch peripherals work with the 68008

Denny Connor
Vitek Systems Inc, Hazelwood, MO

The 68000 family of asynchronous microprocessors does not include asynchronous peripheral devices. The µP family does, however, have an enable output and a valid-peripheral-address (VPA) input, which allow you to construct an external interface for peripherals of the synchronous 6800 family (6821, 6840, 6850, etc).

One object of **Fig 1**'s interface circuit is to generate a properly synchronized $\overline{\text{VPA}}$ signal, which tells the µP (a 68008 in this case) that the present bus cycle will access a 6800 peripheral device. In addition, the interface synchronizes the free-running Enable clock with the 68008's address, data, and control-bus signals.

The falling edge of VPA must occur after that of Enable (**Fig 2**) to ensure the satisfaction of timing specs for the 6800 device. In **Fig 1**, flip-flop IC_{1A} and the 4- to 16-line decoder IC_2 generate the interval $\overline{\text{SYNC WINDOW}}$ and guarantee this condition.

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CIRCLE NO 173

If the 6800 peripheral's decoded address ($\overline{6800ADR}$) goes low during this interval, VPA will go low. If not, the system will remain idle for seven clock cycles (875 nsec), and VPA will go low during the next $\overline{SYNC\ WINDOW}$. To reduce the frequency of these wait periods, $\overline{SYNC\ WINDOW}$ should be as wide as your system will tolerate. Finally, IC_3 and IC_5 generate the pulse $\overline{VPACLR}$, which causes VPA to return to a high level. **EDN**

To Vote For This Design, Circle No 750

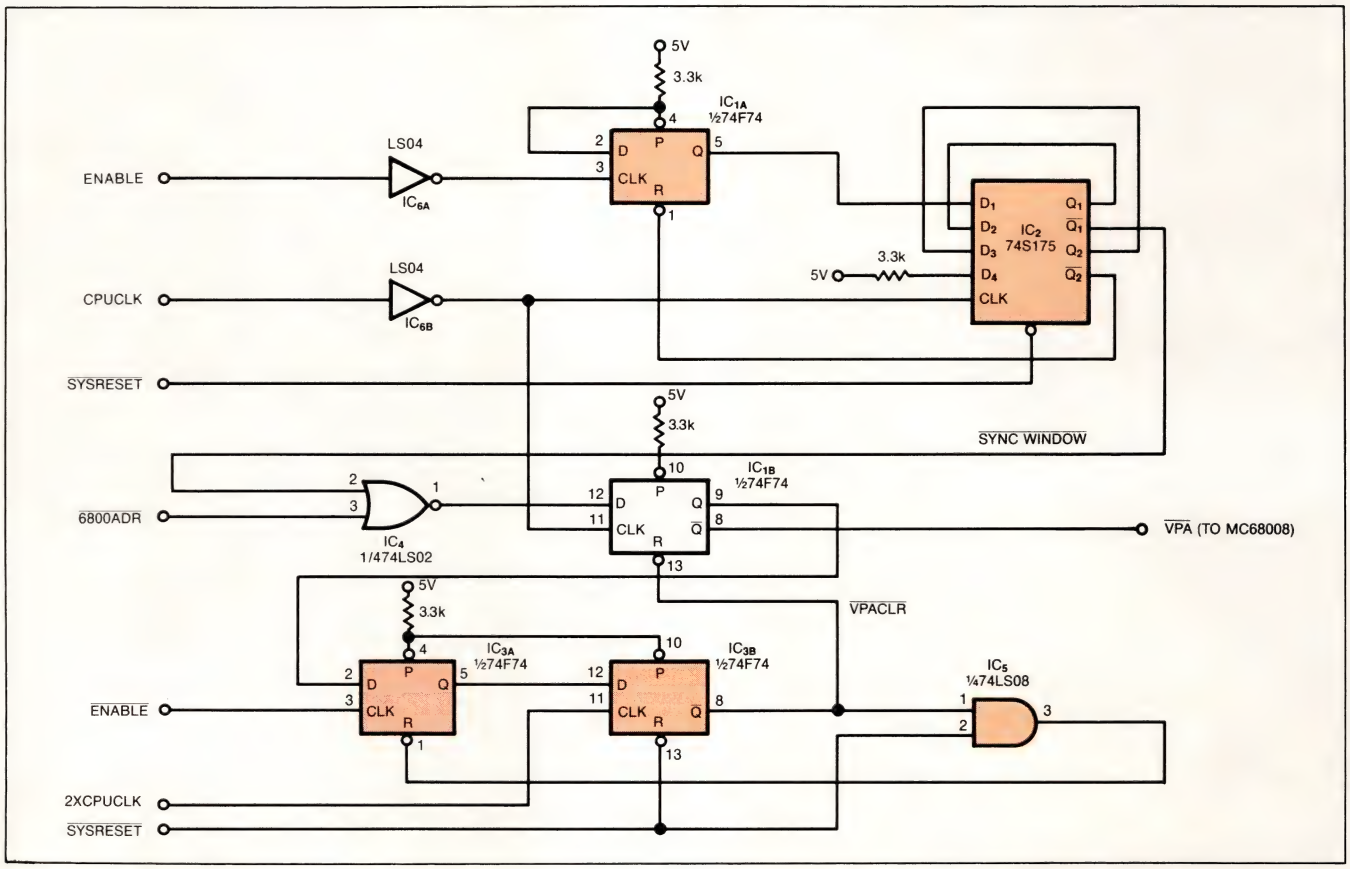

*Fig 1—**This interface circuit allows** peripheral devices of the synchronous 6800 family to operate with the asynchronous 68008 μP.*

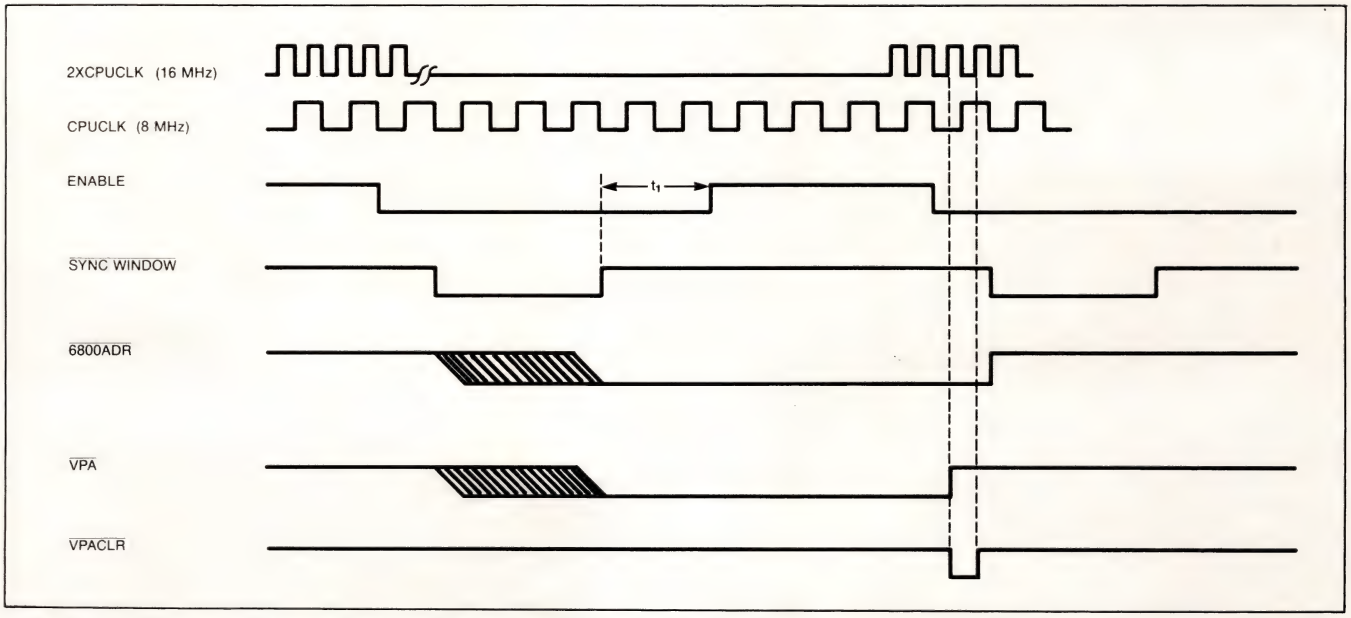

*Fig 2—**These waveforms show the relation of the VPA** (generated by the circuit of **Fig 1**) to other signals in the system.*

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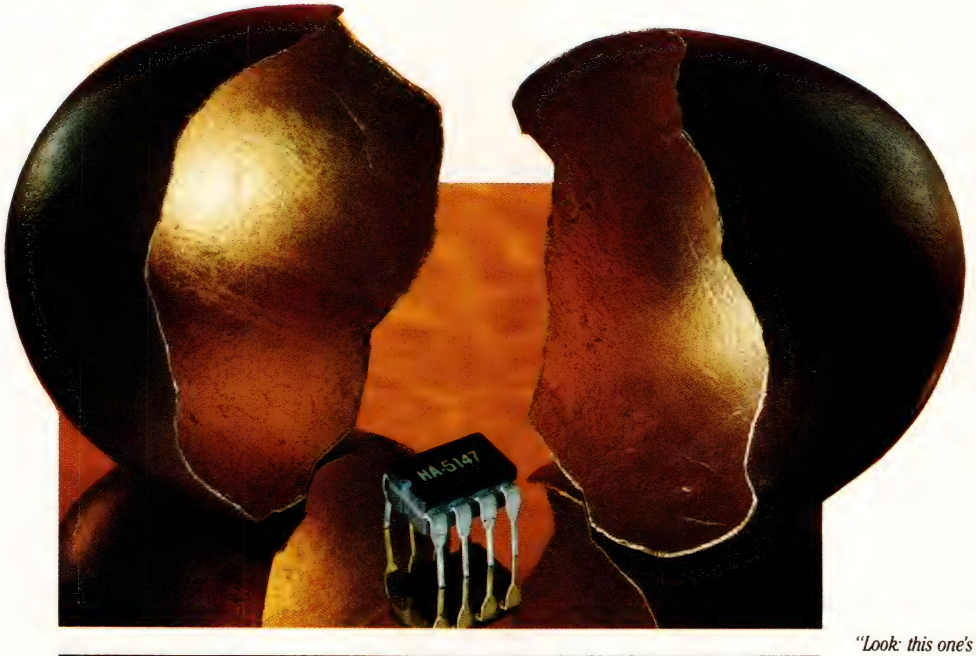

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The winning Design Idea for the January 8, 1987, issue is entitled "Circuit checks remaining battery capacity," submitted by Rolf Zinniker of the Swiss Federal Institute of Technology (Zurich, Switzerland).

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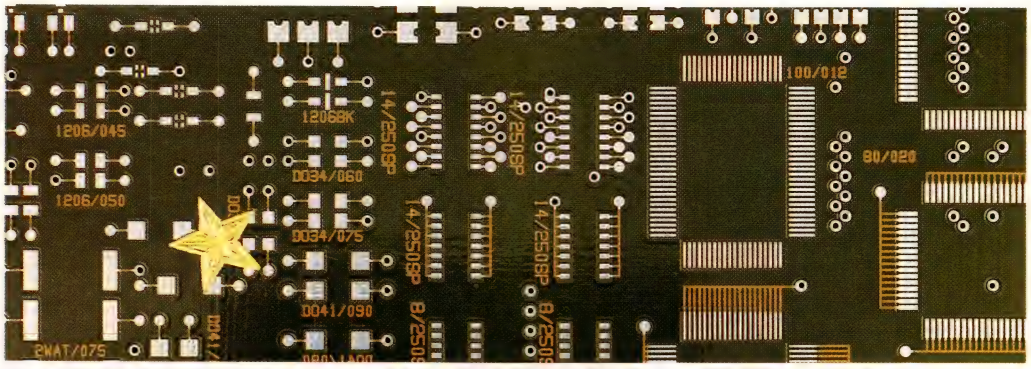

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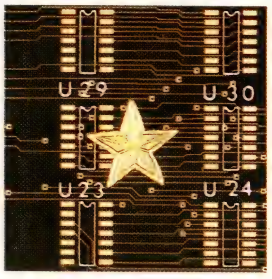

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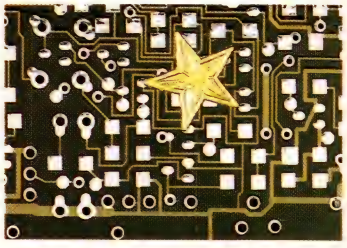
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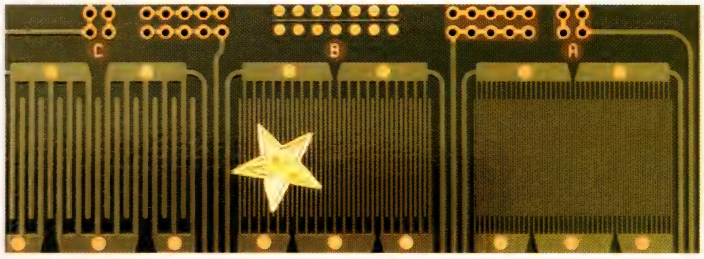

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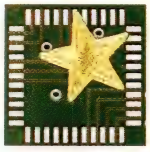
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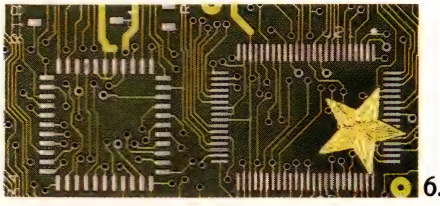
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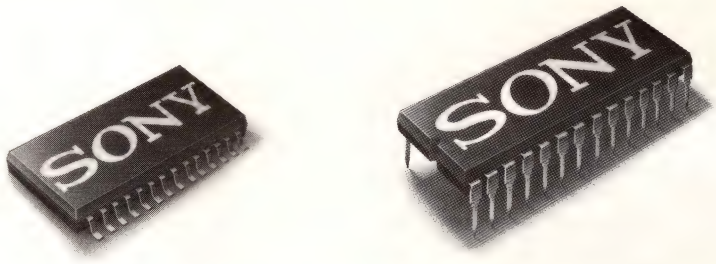

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SONY SRAM DEVICES			
PART NUMBER	ORGANIZATION	SPEED (ns)	PACKAGE
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CXK5816PN—10L/12L	2K x 8	100/120	600 mil DIP
CXK5816M—10L/12L	2K x 8	100/120	SOP*
CXK5416P—35L/45L/55L	4K x 4	35/45/55	300 mil DIP
CXK5864AP—70L/10L	8K x 8	70/100	600 mil DIP
CXK5864AM—70L/10L	8K x 8	70/100	SOP*
CXK5864PN—12L/15L	8K x 8	120/150	600 mil DIP
CXK5864M—12L/15L	8K x 8	120/150	SOP*
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PERFORMANCE OF 32K X 8 SRAM					
PART NUMBER	PROCESS	SPEED (ns)	PACKAGE	DATA RETENTION CURRENT (MAX)	CONDITION
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CXK58256MF—10L/12L	MIX MOS	100/120	SOP	50 μA	0 to 70°C
CXK58256P—10LL/12LL	MIX MOS	100/120	600 mil DIP	10 μA	0 to 70°C
CXK58255P—45/55/70	FULL CMOS	45/55/70	600 mil DIP	5 μA	−30 to 85°C
CXK58255P—45L/55L/70L	FULL CMOS	45/55/70	600 mil DIP	2.5 μA	−30 to 85°C

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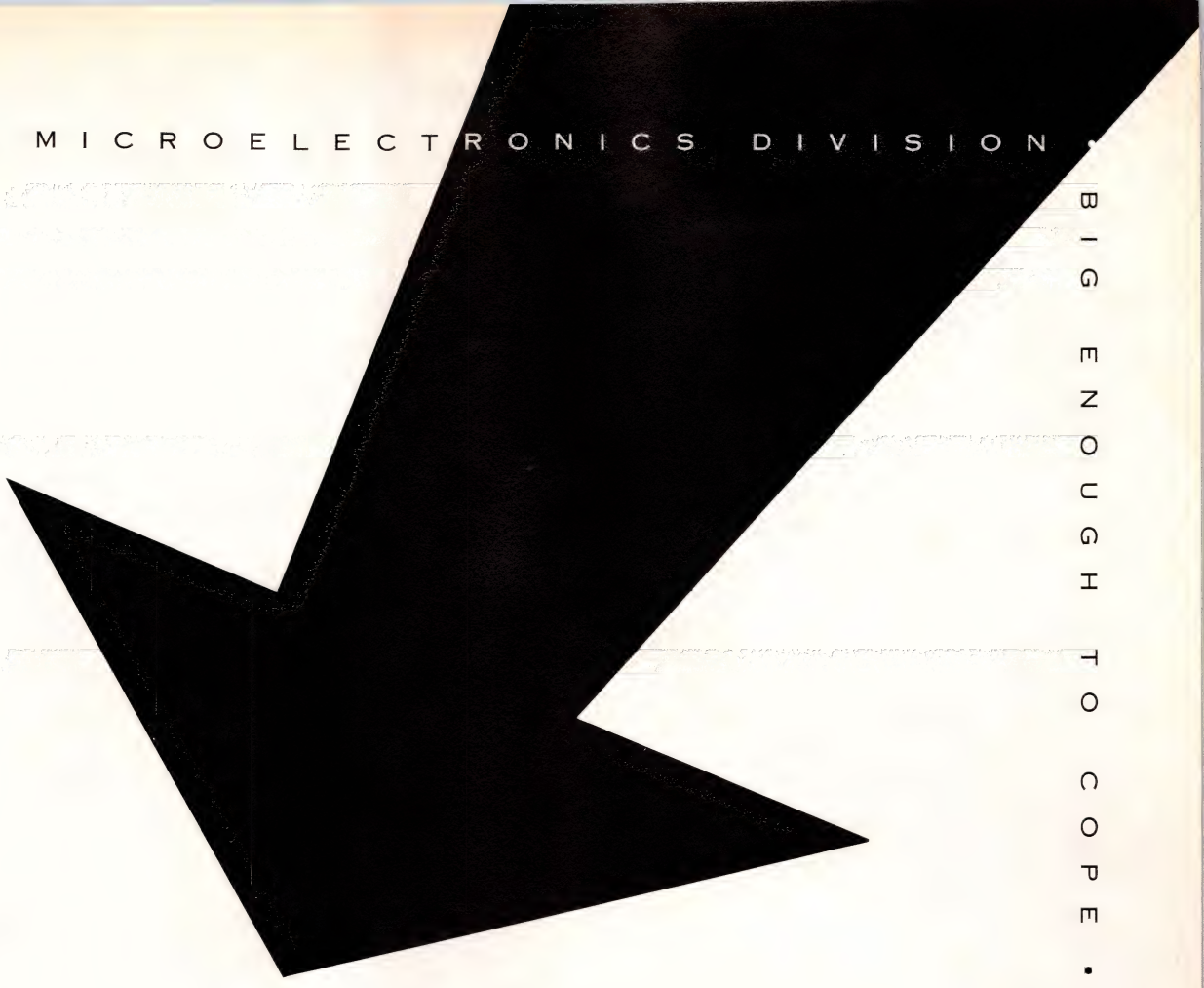

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16K SRAM	HY61C67	16Kx1	25,35,45,55,70	20-pin DIP (300)
16K SRAM	HY61C68	4Kx4	25,35,45,55,70	20-pin DIP (300)
16K SRAM	HY61C69	4Kx4	25,35,45,55,70	22-pin DIP (300)
64K SRAM	HY62C64	8Kx8	100,120,150	28-pin DIP (600)
64K SRAM	HY62C64A	8Kx8	35,45,55,70	28-pin DIP (600)
64K SRAM	HY62C87	64Kx1	35,45,55	22-pin DIP (300)
64K SRAM	HY62C88	16Kx4	35,45,55	22-pin DIP (300)
256K SRAM	HY62C256	32Kx8	55,70,90	28-pin DIP (600)

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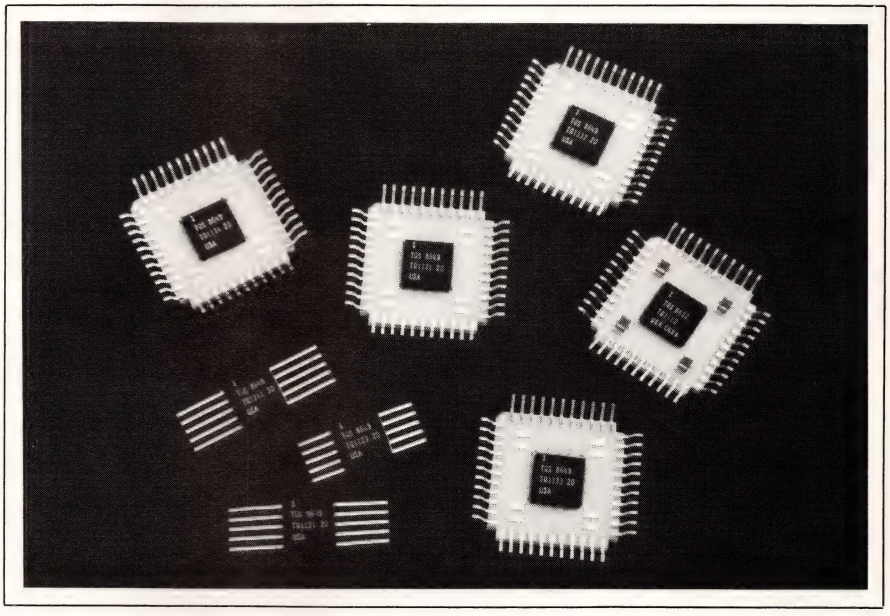

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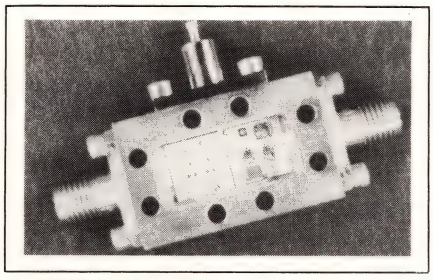
TriQuint Semiconductor Inc, Group 700, Box 4935, Beaverton, OR 97076. Phone (503) 629-3535.

Circle No 351



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Model Bt110 contains eight independent 8-bit D/A converters on one monolithic chip. Each DAC specs a 100-nsec settling time to within a ±1-LSB error band. Differential and integral nonlinearity is ±1 LSB max, and the unit's specs guarantee monotonicity. The eight DACs are arranged in four pairs; each pair shares a common reference amplifier. Designed to interface with standard μPs, the device is TTL compatible. A μP treats the DACs like memory locations. Each DAC has its own address; the μP can load each with data independently. Available in a 40-pin ceramic DIP or a 44-pin plastic J-lead package, $38 (100).

Brooktree Corp, 9950 Barnes Canyon Rd, San Diego, CA 92121. Phone (619) 452-7580. TLX 383596.

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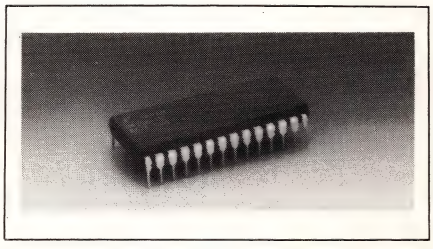


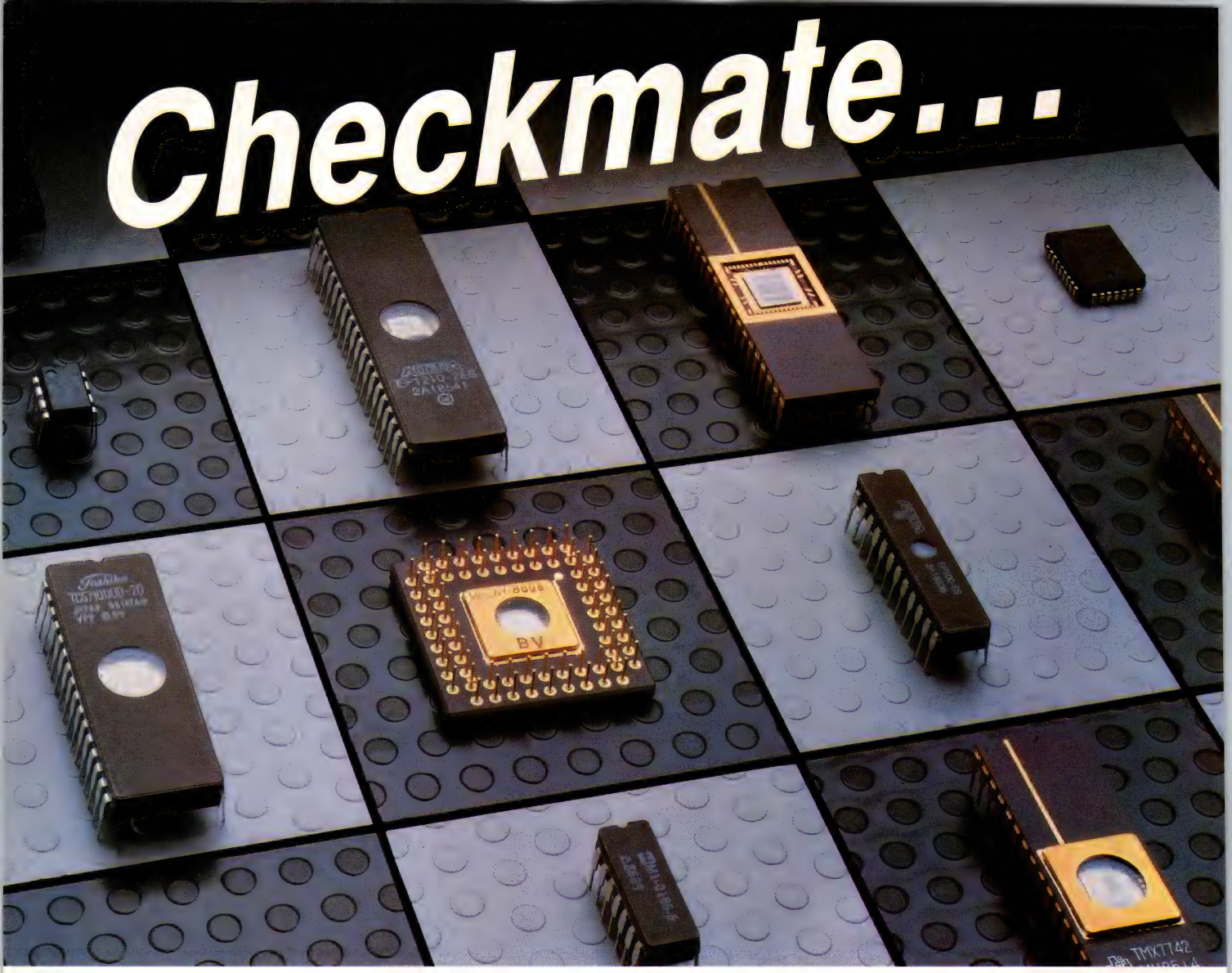
STATIC RAMs

- *TTL-compatible MOS devices*
- *Offer 100-, 120-, and 150-nsec access times*

The MB84256 family of 256k-byte static RAMs offers access times as fast as 100 nsec. The MOS parts are TTL compatible and come in JEDEC-standard 28-pin DIPs, 28-pin gull-wing plastic flat packs, and 32-pad leadless chip carriers. Standard versions offer 100-, 120-, or 150-nsec access times; they dissipate 385 mW in active mode, 16.5 mW in standby. For lower-power applications, the MB84256L and MB84256LL draw only 50 and 5 μA, respectively, in standby mode. The 100-nsec version, $27.95 (100).

Fujitsu Microelectronics Inc, Marketing Communications, 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 562-1000. TWX 910-338-0190.

Circle No 353



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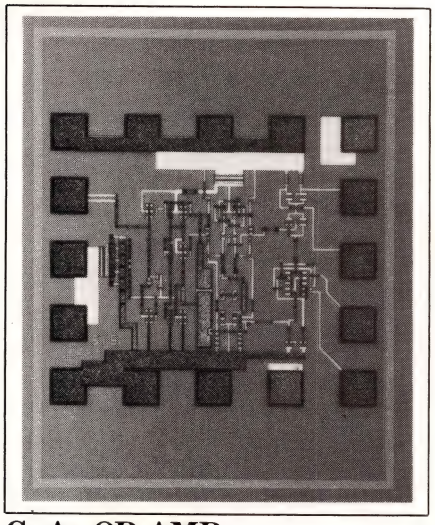

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- *Has 70-MHz full-power bandwidth*
- *Offers stable unity gain*

The AOP 3510 GaAs op amp offers a 1200V/μsec slew rate, 20-nsec settling time, 70-dB open-loop gain, and 350-MHz unity-gain bandwidth. The part is suitable for application in such products as A/D- and D/A-converter amplifiers, S/H amplifiers, fiber-optic systems, and LANs. The amplifier comes in a 16-pin DIP or in die form. A commercial-grade version in a 16-pin DIP (AOP 3510 J3C) costs $32.75 (1000).

Anadigics Inc, 35 Technology Dr, Warren, NJ 07060. Phone (201) 668-5000. TLX 510-600-5741.

Circle No 354

GRAPHICS IC

- *First 7220 graphics chip in a PLCC*
- *Prices reduced for ceramic versions*

Three versions of the industry-standard 7220 graphics controller—including the industry's first PLCC version, according to the manufacturer—are now available. An 8-MHz version in a PLCC costs $9; a ceramic-package version of the 8-MHz devices costs $12; and a 6-MHz ceramic-housed unit costs $10 (10,000). According to the manufacturer, the price of the 6-MHz device reflects approximately a 15% reduction compared with previous industry prices.

Zilog Inc, 1315 Dell Ave, Campbell, CA 95008. Phone (408) 370-8000. TWX 910-338-7621.

Circle No 355

OP AMPS

- *Housed in leadless chip carriers*
- *350-MHz unity-gain buffer and 40-MHz FET-input op amp*

The EL2004 is a 350-MHz unity-gain buffer that's pin compatible with the LH0033, and the EL2006 is a 40-MHz FET-input op amp that's pin compatible with the LH0032. The parts are unique because they come in leadless chip carriers (LCCs), according to the manufacturer. Also available in LCCs are

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UL recognized and CSA certified, Potter & Brumfield's T70 relay switches from 1 milliamp through 10 amps, resistive, on printed circuit boards. All with the same reliability and performance that have made P&B relays the industry standard. And the T70 costs as little as 77 cents in 25,000 piece quantities.

Broad range of ratings
Gold-plated fine silver or silver-cadmium oxide contacts are available in a single pole, double throw configuration. Contacts of either material are UL recognized to switch motor loads up through 1/4 horsepower at 120 volts AC. Silver-cadmium oxide contacts are also rated for 5 amp tungsten lamp loads at 120 volts AC, while silver is rated 3 amps tungsten.

Reliability? Of course!
The T70 relay features simplified construction that enhances reliability while holding cost down. A sealed version is designed for immersion cleaning, and a plastic dust cover model is also available.

Off-the-shelf service
With 20 different T70 models available from stock at P&B, the unit you need is probably available off-the-shelf. Your P&B distributor or sales representative will gladly help you select the model that's just right for your application. Call toll-free 1-800-255-2550 for the name of an authorized Potter & Brumfield distributor or sales representative serving your area. Or call your P&B regional office.

Write for free sample
Write us on your company letterhead, briefly describing your potential application for T70 relays, and we'll rush you a free sample and complete specifications. Potter & Brumfield, A Siemens Company, 200 South Richland Creek Dr., Princeton, Indiana 47671-0001.

Regional Sales:
Braintree, MA, (617) 848-6550;
San Juan Capistrano, CA, (714) 493-4503;
Princeton, IN, (812) 386-2130;
Bristol, England, (0454) 616263.

Potter & Brumfield A Siemens Company

CIRCLE NO 164

Potter & Brumfield Inc., 200 S. Richland Creek Dr., Princeton, IN 47671-0001
☐ Please send more information about P&B T70 relays.
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EDN033187
8701

the EHA2520 and the EHA2620, which are alternate sources for the corresponding products from Harris Semiconductor. Primary applications are military. EHA4-2620-8, $30.50; EHA4-2520-8, $33; EL2004L/883, $135; EL2006L/883, $180 (100).

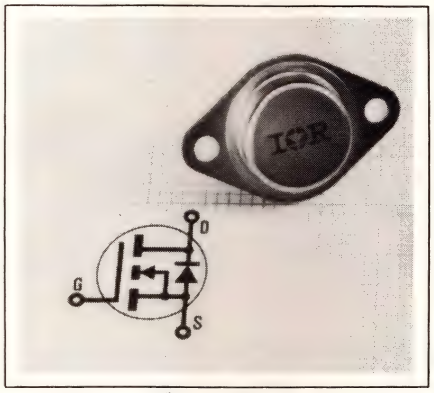
Elantec Inc, 1996 Tarob Ct, Milpitas, CA 95035. Phone (408) 945-1323.

Circle No 356

RAD-HARD MOSFETs

- *Specified to survive at 10^6 rad (Si)*
- *Available in 100, 250, and 500V versions*

Models IRH150, IRH254, and IRH450 are power MOSFETs with ratings of 100, 250, and 500V, respectively. They demonstrate stable threshold and breakdown voltages when subjected to radiation doses



as high as 10^6 rad (Si). In addition, the devices survive transient ionization pulses as high as 10^{12} rad (Si)/sec and return to normal operation within a few microseconds. Representative specs for the IRH150 are 0.055Ω $R_{DS(ON)}$, 38A I_D, and a 1 to 6V $V_{GS(TH)}$. The initial package is a TO-3 can; other package types, voltage ratings, and on-resistance ratings will be available this quarter. IRH150, $493.84; IRH254, $548.72; IRH450, $609.78 (1000).

International Rectifier Corp, Government Products, 233 Kansas St, El Segundo, CA 90245. Phone (213) 607-8887.

Circle No 357

D/A CONVERTER

- *Monolithic 12-bit device*
- *Dissipates 225 mW typ*

Pin-compatible with the industry-standard AD565, the DAC-8565 is a monolithic 12-bit A/D converter that dissipates 225 mW typ, including the power used by the zener voltage reference. The laser-trimmed device maintains monotonicity and ±0.012% linearity over the commercial and military temperature ranges. Typical nonlinearity errors are ±0.006% integral and ±0.007% differential. The settling time is 300 nsec typ, 400 nsec max. The reference output can deliver 2 mA; the typical reference drift is 15

innovation

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Voltage Regulation

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Sawyer Industrial Park, Saugerties, N.Y. 12477 Telephone: (914) 246-3615 TWX 910-333-7572 Telex: 551496

CIRCLE NO 136

See us at Electro Booth 2252 & 2254

ppm/°C. The package is a 24-pin hermetic DIP. D and the premium J commercial grades, $10.29 and $13.71, respectively; military S grade, $24.72 (100).

Raytheon Co, Semiconductor Div, 350 Ellis St, Mountain View, CA 94043. Phone (415) 968-9211.

Circle No 358

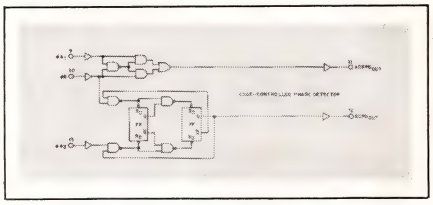
GRAPHICS CHIPS

- *Versions for 68000 and 80XX μPs*
- *Software compatible with HD68845S CRT controller*

The HD6345/HD6445 CRT controller and the HD63645/HD64645 LCD timing controller are software compatible with the industry-standard HD6845S raster-scan CRT controller; the 6345/6445 is pin compatible with its counterpart as well. The two versions of each device operate with 68000 family μPs and 80XX-family μPs, respectively. The HD6345/HD6445 controls a 256-character×256-line CRT screen at a clock rate of 4.5 MHz. It provides four split screens, smooth scrolling, two programmable cursors, and dual-port memory access. The package can be a 40-pin DIP or a 52-lead PLCC. The HD63645/HD64645, on the other hand, offers programmable control of LCD screens with a resolution of 2048×1024 dots, a display ratio based on a 1:512 duty cycle, and a character font that is one to 32 dots high by eight dots wide. This device provides scrolling both horizontally by character and vertically by dot. The package is an 80-pin plastic flat pack. HD63645/HD64645, $7.10; HD6345/HD6445, $4.20 (10,000).

Hitachi America Ltd, Semiconductor & IC Div, 2210 O'Toole Ave, San Jose, CA 95131. Phone (408) 435-8300. TLX 171581.

Circle No 359



CMOS DIGITAL PLL

- *Accuracy depends on clock signal and propagation delays*
- *You can trade lock time for loop bandwidth*

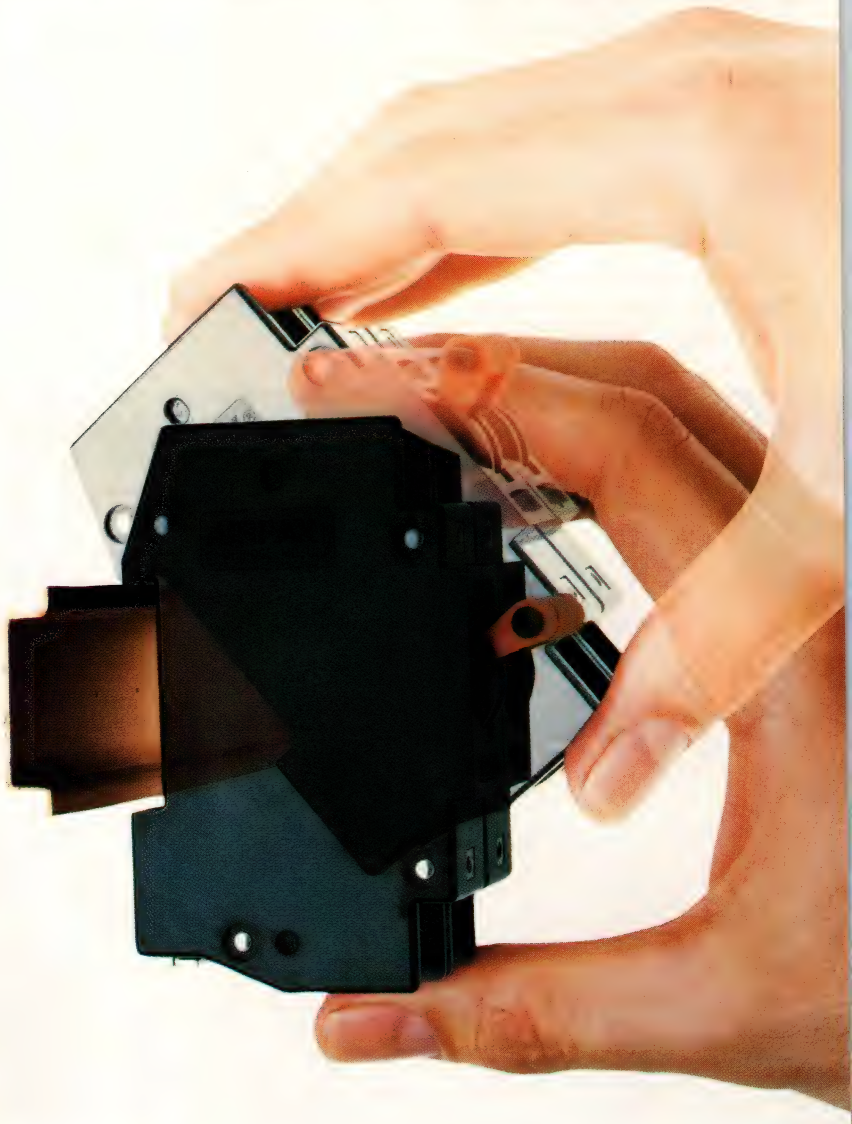
The CD54/74HC/HCT297 digital phase-locked loop (PLL) performs PLL functions without using analog components. The accuracy of the monolithic devices depends on the external clock signal and the internal propagation delays rather than on the supply voltage, component tolerance, and temperature variations. By programming the address inputs of an internal 3- to 17-stage counter, you can trade lock time for loop bandwidth: Three stages give

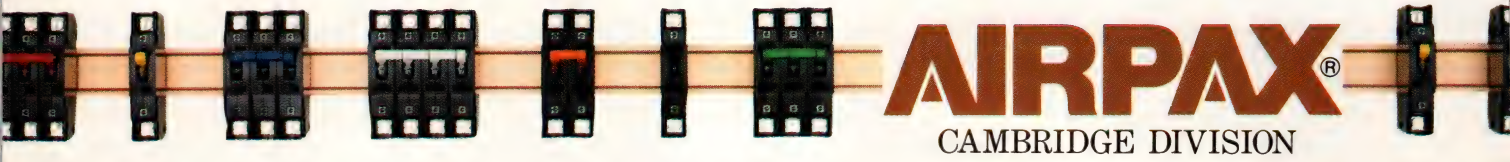
NOW MAGNETIC CIRCUIT BREAKERS BELONG ON YOUR DIN RAIL.

So what's a DIN rail? It's a concept developed in Europe for quick and easy mounting of electrical and electronic devices. And now that concept includes something new. Airpax introduces magnetic circuit breakers made specifically for the 35mm symmetric rail. They snap on. They snap off. That's why DIN rails are all over Europe—and why they're coming to the U.S. as well.

Leave it to Airpax to combine the simplicity of the rail-mount design with the superior performance of magnetic circuit breakers. These new IELR breakers feature ratings from 0.050 to 50 amps with toggle-style handles in a choice of seven colors. They're UL recognized and meet CSA certification and VDE spacing requirements. Best of all, they're the only rail-mounting circuit breakers which offer the performance and quality that have earned them the Airpax name.

Now is your chance to get a head start in the U.S. while you expand your marketing potential in Europe. With magnetic rail-mounting circuit breakers—a great new idea backed by an old commitment to excellence. Your first step is easy. In fact, it's a snap. Call or write for more information. Airpax Corporation, Cambridge Division, Woods Road, Box 520, Cambridge, MD 21613, (301) 228-4600. Fax: (301) 228-8910. A North American Philips Company.





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you wide bandwidth with a short lock time, for example. The counter operates to 55 MHz. The digital PLL includes an exclusive-OR and an edge-controlled phase detector; each is suitable for use in ripple cancellation. The device comes in a 16-pin DIP; the nominal supply voltage is 5V. CD74HC/HCT297E, $8.42 (100).

GE/RCA Solid State, Route 202, Somerville, NJ 08876. Phone (201) 685-7106.

INQUIRE DIRECT

DMOS FET

- *Offers pin compatibility with standard JFETs*
- *Gain-bandwidth product of 1 GHz*

The SD2100DE DMOS FET is pin compatible with industry-standard JFETs, but it provides an order-of-magnitude higher gain-bandwidth product of 1 GHz. The operating bandwidth exceeds 400 MHz. A normally on device, the FET specs an on-resistance of 150Ω and an operating voltage of 20V. The SD2100DE is available in die form or in a TO-72 hermetic package. TO-72 version, $1.15 (100).

Topaz Semiconductor Inc, 1971 N Capitol Ave, San Jose, CA 95132. Phone (408) 942-9100. TWX 910-338-0025.

Circle No 361

LINE-ISOLATION IC

- *Provides frequency discrimination*
- *10 standard products available*

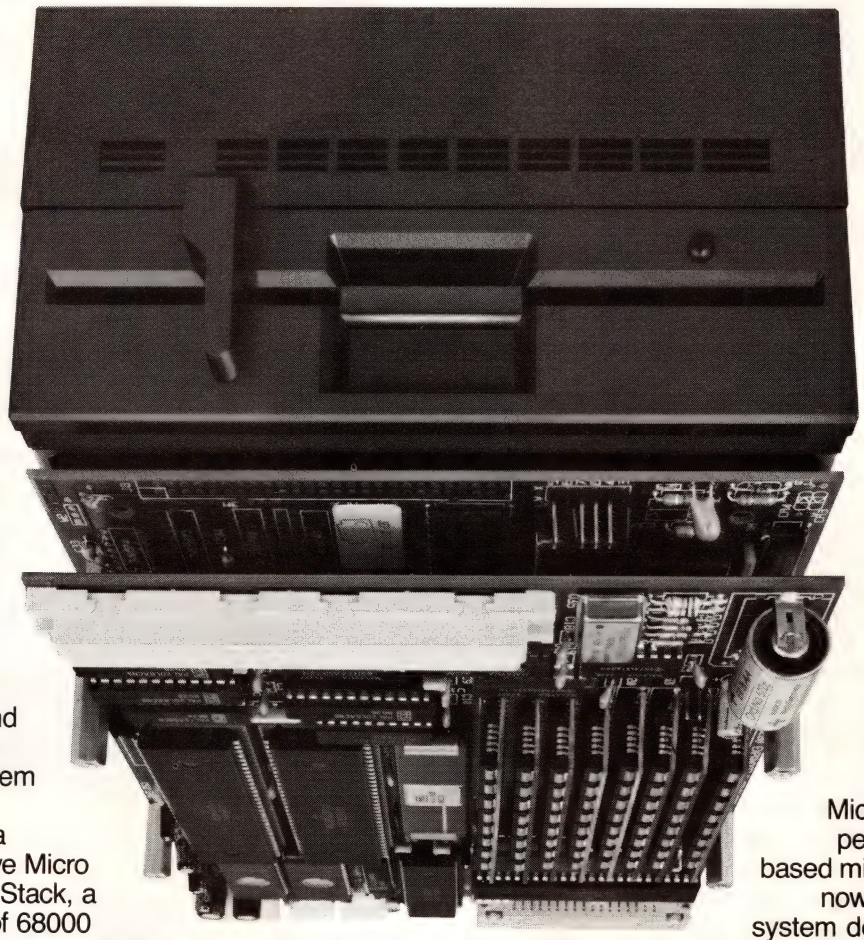
The LS7501 through LS7510 Series tone-activated line-isolation ICs are suitable for use in testing telephone lines for continuity or for automatic reading of digital electric, gas, and water meters in the home. Each of the 10 standard-frequency versions (2683 to 2983 Hz at 30-Hz intervals) includes an oscillator, a timer, and control logic; these features allow each version to respond to the frequency for which it was designed. The circuit samples the input frequency at 0.5-sec intervals; if the input remains within ±10 Hz of the IC's standard frequency for 4.5 sec, the circuit responds with a 20-sec disconnect signal, then resets. The manufacturer can mask-program the sample interval and the disconnect time as you request, and it can program the IC's frequency in 1-Hz steps from 11 to 4095 Hz. The circuit's supply-voltage range is 2.5 to 6V; its package is a 16-pin DIP. $1.70 (1000).

LSI Computer Systems Inc, 1235 Walt Whitman Rd, Melville, NY 11747. Phone (516) 271-0400.

Circle No 362

HARDWARE STACK™

THE NEXT LEVEL OF MODULARITY FOR 68000 MICROCOMPUTER SYSTEMS



Looking for a more compact, reliable and cost effective microcomputer system for industrial OEM applications? Take a close look at Creative Micro Systems' Hardware Stack, a unique new family of 68000 microprocessor-based, board-level modules & systems.

A Practical Design Breakthrough

Hardware Stack represents a practical breakthrough in microcomputer system design. Stackable boards and modules are used to create the next level of modularity. As boards have been in the past, now whole systems have become modular slide-in units.

More Cost Effective & Compact

Hardware Stack systems are created by stacking & suspending boards beneath 5¼ inch drives. In this way, boards stack together to become compact, quickly interchangeable, modular systems. A private HSbus™ allows interconnection between boards through DIN connectors and eliminates the need for card cage or expensive multi-layer mother board.

The result? A highly reliable compact system reduced 40 to 60 percent in size over comparable systems offering similar operating capabilities. And, at a significantly reduced cost.

68000 Microcomputer Now Available

The completely new HS200 Expandable Microcomputer is a high performance MC68000 based microcomputer module now available for serious system design.

The HS200 features: ■ Two Megabytes of RAM ■ 128K of EPROM ■ Two RS-232 Serial Ports ■ Parallel Printer Port ■ Real Time Interrupt Circuit ■ Quartz Time/Date Subsystem ■ Dual DMA Controller.

Add the HS520 Disc Controller, HS410 Buffered Utility Prototyping Board or other available modules for enhanced performance. Then support all this with Microware Systems' Professional OS-9 software.

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CREATIVE MICRO SYSTEMS
3822 Cerritos Avenue
Los Alamitos, California 90720 USA
Telephone (213) 493-2484

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In EUROPE: Micro-Marketing (Elec.) Ltd., Unit 4, Soho Mills Ind. Estate, Wooburn Green, High Wycombe, Bucks, England HP10 OPF Telephone (06285) 29222 Telex 848080 MICRO G

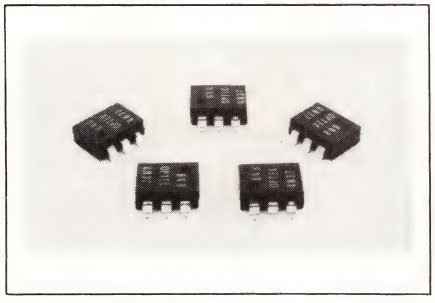
DUAL-PORT MEMORY

- *Features 30-nsec output-enable time*
- *55-nsec address-access time*

The MS6130 1k×8-bit dual-port memory has a 55-nsec address-access time and a 30-nsec output-enable time, rendering it suitable for use with an 80386 or 68020 μP operating at 25 MHz. The CMOS device draws 1-μA typ standby current and 65-mA typ operating current. You can order it in a 48-pin plastic or side-brazed DIP. For the standard and low-power versions, in 120-, 90-, 70-, and 55-nsec grades and in plastic packages, $13.40 to $20 (100).

Mosel, 914 W Maude Ave, Sunnyvale, CA 94086. Phone (408) 733-4556.

Circle No 363



OPTOISOLATORS

- *6-pin units available in surface-mount packages*
- *Different surface-mount styles for each type*

The entire line of UL-approved, 6-pin DIP optoisolators from this manufacturer is now available in surface-mount packages. Device outputs include phototransistor, high-voltage phototransistor, photo-Darlington, high-voltage photo-Darlington, ac input, photo SCR, triac drive, Schmitt trigger, and bilateral analog FET. Type-SMA devices rest directly on the pc board; SMB types are supported 0.005 in. above the board. $0.42 to $1.60 (1000).

Optek Technology Inc, 345 Industrial Blvd, McKinney, TX 75069. Phone (214) 542-9461.

Circle No 364

S/D CONVERTER

- *Tracks at 7200°/sec*
- *Offers 2.6-arc/minute accuracy*

The HSD/HRD1024 is a 14-bit hybrid, μP-compatible synchro (resolver)-to-digital converter. It includes a reference-signal synthesizer that reduces the error effect of speed voltage at high rpm, and a built-in test (BIT) output that provides a logic one when the tracking error exceeds ±1°. You can specify the commercial, industrial, or military operating temperature range; a 60-, 400-, or 800-Hz reference frequency; an 11.8, 26, or 90V rms input-voltage range; and ±5.2- or 2.6-arc/minute accuracy. The converter comes in a 36-pin hermetic

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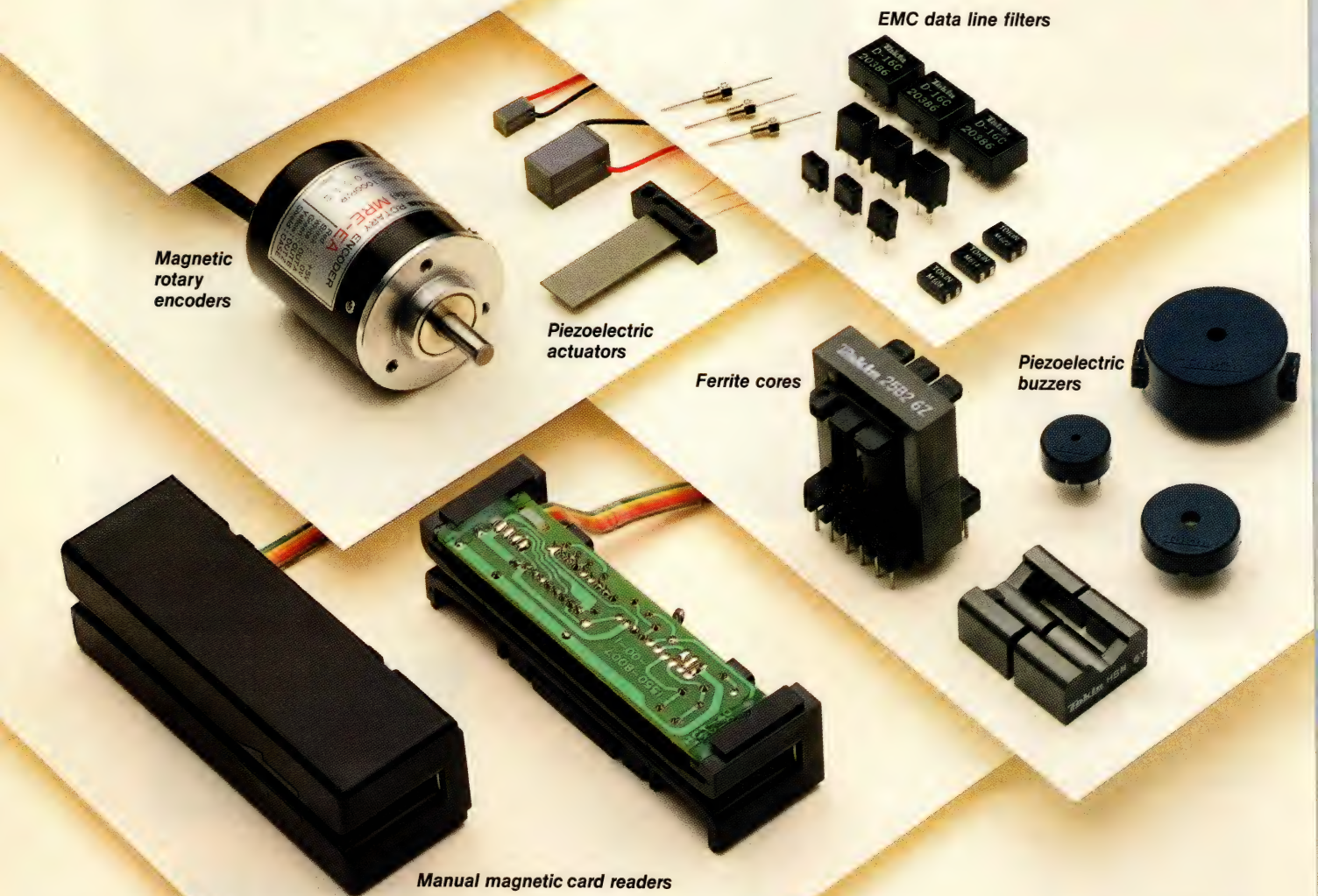
Tokin has many new products to offer you, and we look forward to showing them to you at Electro/87, April 7—9, 1987, in New York City. We'll be in booths #2079 and #2081.



Tokin

Tokin Corporation

Head Office: Hazama Bldg., 5-8, Ni-chome, Kita-Aoyama, Minato-ku, Tokyo 107, Japan
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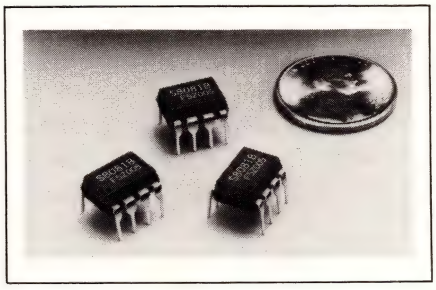
CIRCLE NO 191

double-width DIP. HSD/HRD1024-1405 version, $430.

Natel Engineering Co Inc, 4550 Runway St, Simi Valley, CA 93063. Phone (805) 581-3950. TWX 910-494-1959.

Circle No 365



CMOS TIMER

- *Includes voltage reference that stabilizes oscillator*
- *Has circuit that prevents chattering at the trigger input*

Model S-8081B is a CMOS IC that includes an RC oscillator, a 20-stage divider, a power-on clear circuit, and a circuit that prevents chattering at the trigger input. The IC also has a voltage reference that stabilizes the oscillator, and it includes level shifters and an output transistor. An inverted trigger output and set/reset controls are available. The device operates from a 4.5 to 16.5V supply and draws 200 μA max with the output open. It comes in an 8-pin plastic DIP. $2 (1000). Delivery, stock to eight weeks ARO.

Seiko Instruments USA Inc, 2990 W Lomita Blvd, Torrance, CA 90505. Phone (213) 530-8777.

Circle No 366

UART

- *Optimized for use with IBM PC, PC/XT, and PC/AT data buses*
- *Its software is compatible with the IBM PC/AT*

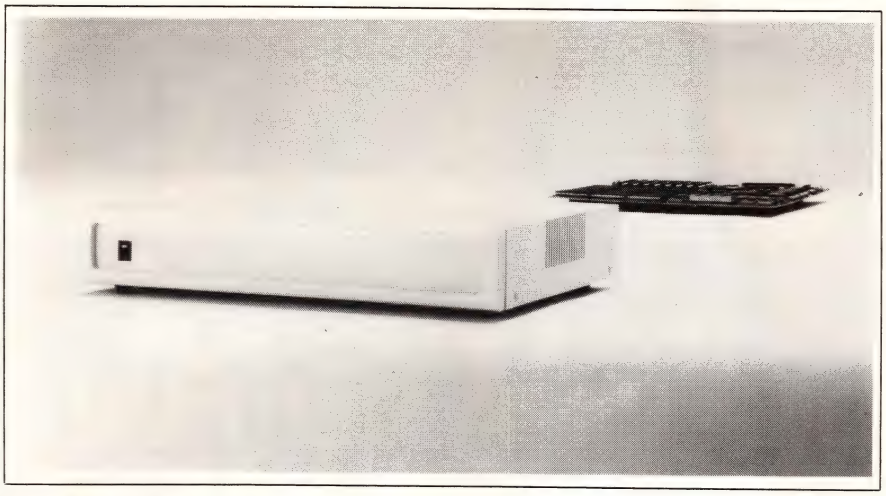
You can use the 82050 asynchronous communications controller, a universal asynchronous receiver/transmitter (UART), in modem applications for the IBM PC, PC/XT, PC/AT, and IBM PC-compatible computers, and in the company's 89024 modem chip set. The UART provides an RS-232C port for personal computers, workstations, terminals, PBX equipment, and printers. Housed in a 28-pin DIP or PLCC, the UART simplifies the interface to an IBM PC, PC/XT, PC/AT, or IBM PC-compatible data bus by providing the required I/O pins. The 82050 is software compatible with the IBM PC/AT and also with industry-standard UARTs, such as the INS8250 and -16450 devices. $4.40 (10,000).

Intel Corp, Literature Dept #W345, Box 58065, Santa Clara, CA 95052. Phone (916) 351-6289.

Circle No 367

NEW PRODUCTS

COMPUTERS & PERIPHERALS



PLATFORM

- *Vector-based platform for desktop publishing*
- *Works with IBM PC/XTs, PC/ATs, and compatibles*

Using vector technology instead of raster technology, the Total Image Processor I (TIP I) provides electronic-publishing capabilities. Designed for use with IBM PC/XTs, PC/ATs, and compatibles, the TIP I uses custom VLSI graphics-processing chips to manipulate data. These chips include processors for vector rasterization and fill-in, raster vectorization, raster graphics, outline rasterization, bit-set processing, and page compilation. The host interface for the TIP I is the IBM PC/AT bus. $5000 (sample qty).

Sumitronics, 580 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7683.

Circle No 368

ACCELERATOR

- *IBM PC/AT-compatible board operates at 5 MIPS*
- *CPU module operates at 30 MHz*

The ZAIAZ 933 computer engine is an IBM PC/AT-compatible board that runs a Fairchild Clipper CPU module at 30 MHz. The system includes 4M bytes of RAM on a companion board. The companion board has onboard refresh logic, and you can expand its RAM to 16M bytes. The CPU features hardware support for demand-paged virtual memory with a 4G-byte virtual address space. The board operates at 1M flops and doesn't require a PC interrupt line. The computer engine takes advantage of all the IBM PC/AT's peripherals and communications ports and utilizes any improvements you make to the PC. An expansion connector allows user-designed cards to work directly with the board without disturbing the PC's configuration. $9750.

ZAIAZ International, 2225 Drake Ave, Huntsville, AL 35805. Phone (205) 881-2200.

Circle No 369

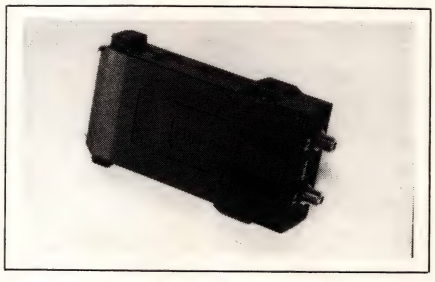
ACCELERATOR

- *386-based accelerator board for the IBM PC/XT, PC/AT*
- *Runs the 80386 μP at 16 MHz*

The PC-elevator 386 accelerator board plugs into an IBM PC bus and converts an IBM PC/XT, PC/AT, or compatible computer to an 80386-based workstation. Unlike some accelerator boards, the PC-elevator 386 can operate with an 8088-based PC. The board runs an 80386 at 16 MHz with no wait states and a 32-bit bus. The board also features 1M byte of onboard, high-speed (100-nsec access time) RAM, which you can expand to 16M bytes. The vendor rates the board's operation at 4 MIPS and claims it scores 18.5 on the Norton SysInfo Scale. You can further enhance the board's performance by adding an 80287 or 80387 floating-point coprocessor chip. You can plug the board into an expansion slot and run it without removing the host processor. The accelerator works in tandem with the host processor, which it uses to handle I/O functions. $1995.

Applied Reasoning Corp, 86 Sherman St, Cambridge, MA 02140. Phone (617) 492-0700. TLX 6714194.

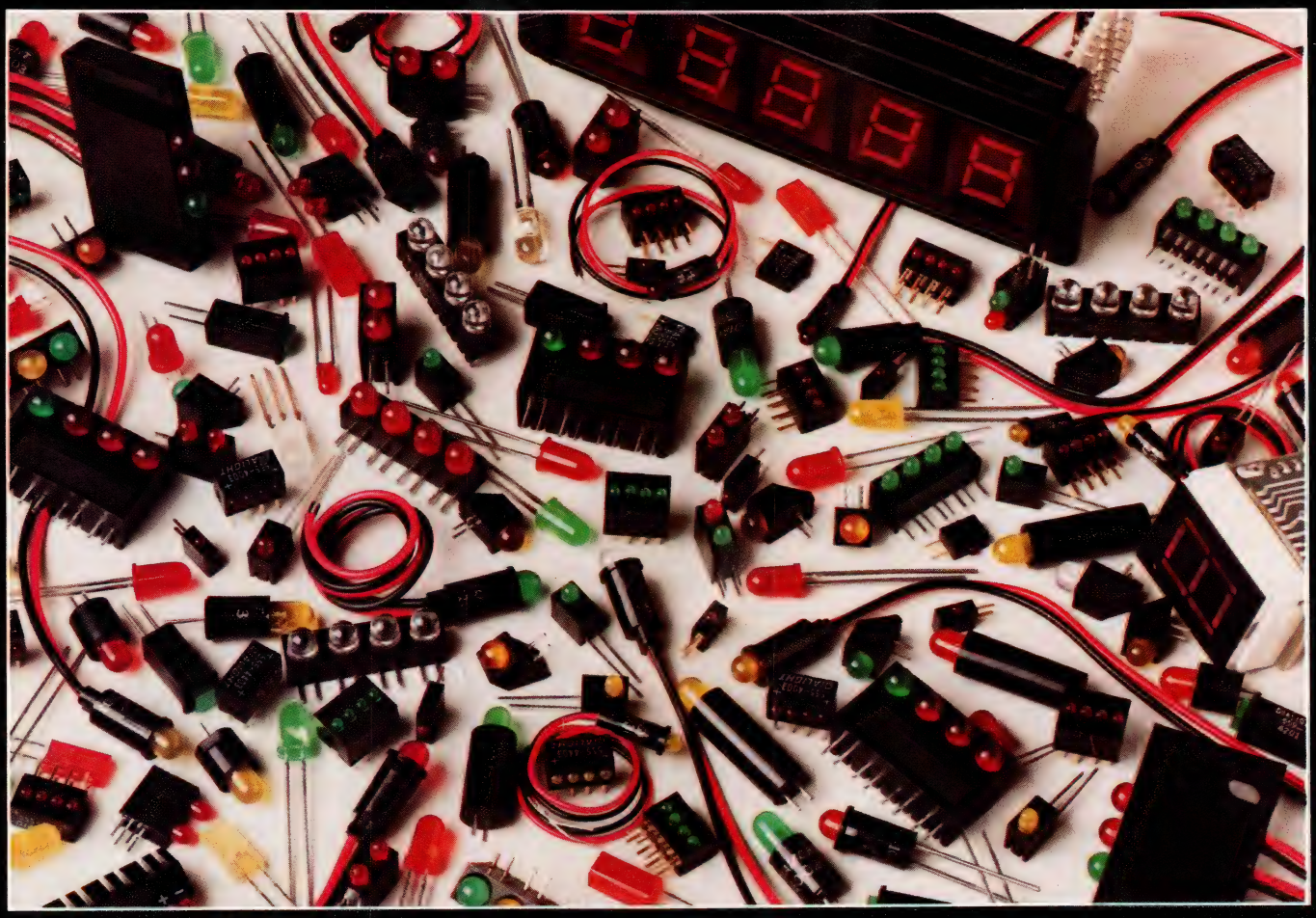
Circle No 370



F-O MODEMS

- *Asynchronous or synchronous models available*
- *Offer 2-mile range and 19.2k-bps data rate*

The FOM-6A and FOM-6S fiber-optic modems provide low attenuation, EMI/RFI immunity, security from eavesdropping, and electrical isolation. The modems operate to 19.2k bps over a range of 2 miles max. The FOM-6A operates asynchronously; the FOM-6S is a synchronous modem. Neither device requires ac power, and both devices operate in



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CIRCLE NO 141

Solve special decoupling problems

MICRO/Q capacitors with special pinout configurations give you design flexibility you can't get with standard techniques to solve decoupling and routing problems. Choose MICRO/Q for 8-, 16-, or 32-bit microprocessors, ECL devices, and many other devices where power and ground are not at conventional positions. You'll get superior noise suppression and design ease.

CIRCLE 200

Improve existing board performance

MICRO/Q capacitors can be retrofitted to solve noise problems on existing boards. Because MICRO/Q caps share mounting holes with existing IC pins, no board redesign is required. Effective decoupling becomes a matter of adding one insertion step.

CIRCLE 201

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MICRO/Q ceramic decoupling capacitors share board mounting holes with IC pins. You don't have to waste space on additional holes, as you do for standard caps. Simplifying board design opens up two very attractive options. Add more active devices with increased packaging density in the same space, or design the same package on a smaller board. Either way, you win with MICRO/Q.

CIRCLE 202

noise problems... space problems...

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Rogers MICRO/Q® decoupling capacitors reduce voltage noise spikes in IC's, often by as much as a factor of ten. And since they're easily mounted *underneath* the IC, MICRO/Q capacitors conserve valuable board real estate, too. A range of configurations makes MICRO/Q flat capacitors especially effective at reducing noise on:

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- Single-board computers

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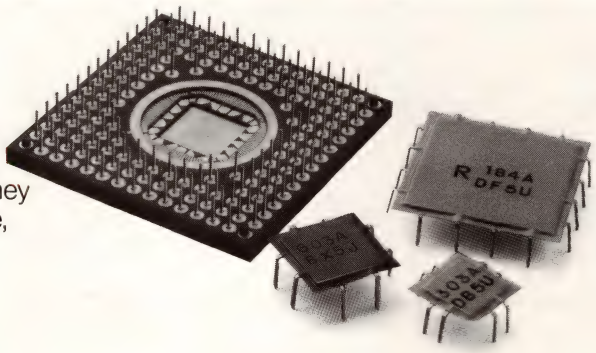
CIRCLE 203

Design noise out of PGA and LCC packages

PGA MICRO/Q capacitors provide effective solutions to noise problems with VLSI PGA packages and LCC sockets. Design effective decoupling on complex multi-layer board layouts by fitting PGA MICRO/Q capacitors under PGA or LCC sockets. They occupy no additional board space and provide the low-inductance, high-frequency decoupling required by today's VLSI packages. Available in a range of pinout configurations.



CIRCLE 204

either full- or half-duplex modes. The FOM-6A features a DCE/DTE switch, which eliminates the need for cross-cabling. You can strap the FOM-6S for internal, external, or loopback clocking modes. FOM-6A, $149; FOM-6S, $249.

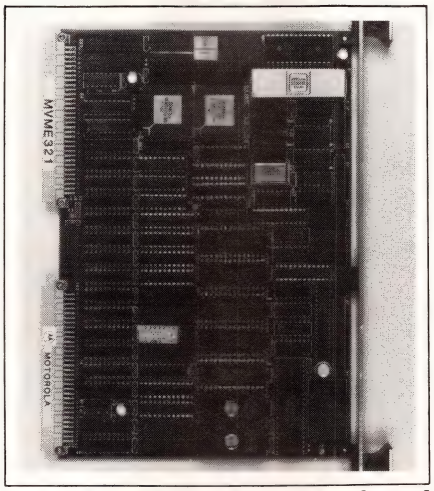
RAD Data Communications Inc, 151 W Passaic St, Rochelle Park, NJ 07662. Phone (201) 587-8822.

Circle No 371

DRIVE CONTROLLER

- *Disk controller uses DMA and data caching*
- *Board includes a 10-MHz 68010*

The MVME321 disk-drive-controller board can handle one or two 5¼-in., ST-506-compatible Winchester disk drives and as many as four 5¼-in., SA-400-compatible floppy-disk drives. A multitasking executive kernel, which supports concurrent operations, manages onboard control. This capability, combined with a RAM buffer and DMA, makes the drive controller useful in applications requiring intensive real-time disk I/O such as image processing. The board allows DMA transfers to take place at 8M bytes/sec over the VME Bus. Driver software for the VersaDOS and SYSTEM V/68 operating systems comes with the MVME321. $2295.



Motorola Inc, Box 52073, Phoenix, AZ 85044. Phone (602) 438-3501.

Circle No 372

MEMORY BOARD

- *Provides 8M bytes of parity-checked RAM*
- *Supports unaligned and block-mode data-bus transfers*

The Model 2501-4280-5 double-Eurocard dynamic-RAM board is a VME Bus-compatible memory board sporting 8M bytes of parity-checked dynamic RAM. The RAM has a read-access time of <200 nsec, a write-access time of <80 nsec, a cycle time of <300 nsec, and hidden refresh. The board supports 8-, 16-, and 32-bit data transfers, including unaligned and block transfers. It recognizes 24- and 32-bit VME Bus addresses and is jumper selectable

Cutler-Hammer® aerospace relays meet a wide range of MIL-SPEC applications!

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That's because each Cutler-Hammer relay is backed by extensive R&D; a worldwide, well-structured distribution network and knowledgeable, professional service.

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For more information, contact your Cutler-Hammer sales office or distributor. Or send for our complete catalog. Eaton Corporation, Aerospace & Commercial Controls Division, 4201 N. 27th St., Milwaukee, WI 53216. Or call 414-449-7487.

EATON

Aerospace, Commercial, Miniature, Illuminated Switches and Relays.

CIRCLE NO 144

on 1M-byte address boundaries. The board's documentation includes information on how to program a PAL device so that you can alter the board's address-modifier decoding. $4400.

Microproject bv, Claus Sluterweg 125, 2012 WS Haarlem, The Netherlands. Phone (023) 292084. TLX 71189.

Circle No 380

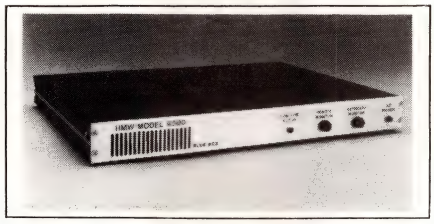
Microproject Corp, 4676 Admiralty Way, Suite 617, Marina Del Rey, CA 90292. Phone (213) 306-8000. TLX 556443.

Circle No 373

INTERFACE

- *Drives remote monitors and keyboards for the IBM PC*
- *Converts IBM digital video to RS-170 RGB and sync*

The Model 9500 IBM PC Remote Interface provides a transparent,



remote interface between the IBM PC and monitors and keyboards. It allows you to place monitors and keyboards as far from the PC as 4000 ft, so you could, for example, use the peripherals in a factory while keeping the PC in a less stressful environment. The interface converts the PC's digital video signals to RS-170 RGB and sync format, and it converts an RS-422 serial keyboard to the IBM PC's serial keyboard format. It also adapts the RS-232C communications I/O to RS-422 format. $1000.

HMW Enterprises Inc, 604 Salem Rd, Etters, PA 17319. Phone (717) 938-4691.

Circle No 374

MODEM BOARD

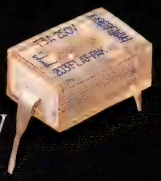
- *Operates on the G64 and G96 buses or by itself*
- *Provides autodial and autoanswer facilities*

The Gesmod-1 single-Eurocard modem-controller board for G64 or G96 Bus systems includes an onboard 8031 microcontroller to provide autodial, autoanswer, and autoredial functions. It handles pulse and DTMF dial modes. The modem provides main-channel transmission rates of 1200 baud (half duplex) or 300 baud (full duplex). Back-channel transmission rates of 5 to 75 baud or 5 to 150 baud are available, depending on the modem chip used. The modem is compatible with Bell 103/108/113, Bell 202, and CCITT V.21 and V.23 specifications, and all modem parameters are programmable. For stand-alone operation, you can operate the modem via its onboard RS-232C interface. Ap-

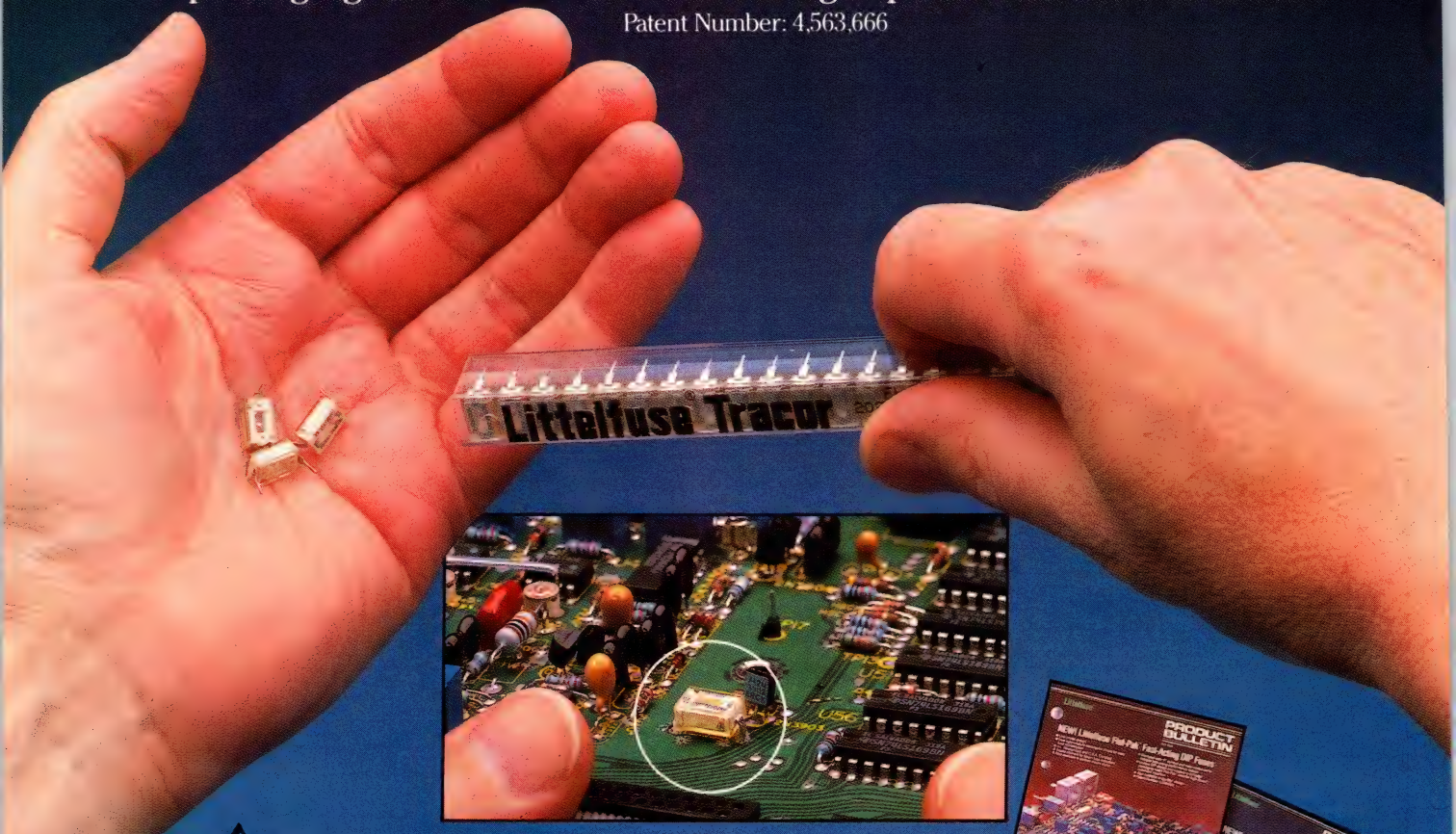
New Product File

Flat-Pak™ DIP & SMD Fuses

• Slo-Blo® design: 250 Volts, 1 thru 5 Amperes, Stamped "T" and color-coded blue. • Fast-Acting design: 250 Volts, 1/16 thru 5 Amperes, Stamped "F" and color-coded red. • New low profile rectangular shape (.346″(L) x .245″(W) x .160″(H)) for easy fuse identification. • U.L. Recognized and C.S.A. Certified. • Visible element for blown fuse indication. • Available with DIP or surface mount styles. • Unique DIP design and magazine cartridge packaging make Flat-Pak™ ideal for high speed automatic insertion.



Patent Number: 4,563,666



Call your Littelfuse representative, distributor or (312) 824-1188 for Flat-Pak Product Bulletins 1025 and 1026, samples, pricing and delivery dates.

Making good ideas work for you.

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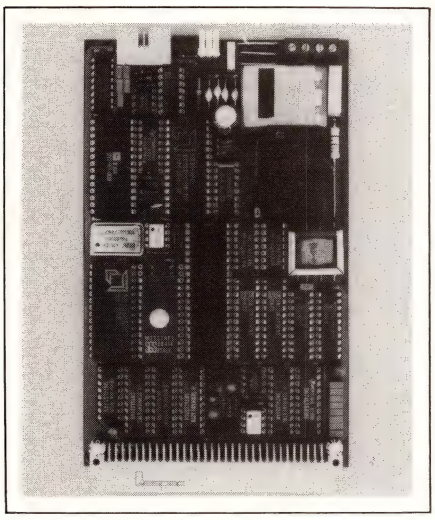
(312) 824-1188

CIRCLE NO 156



proximately $900.

Gespac sa, 3 chemin des Aulx, 1228 Plan-les-Ouates/Geneva, Switzerland. Phone (022) 713400. TLX 429989.

Circle No 375

Gespac Inc, 100 W Hoover Ave, Suite 11, Mesa, AZ 85202. Phone (602) 962-5559.

Circle No 382

SINGLE-BOARD μC

- *Board features an MC68020 operating at 12.5 or 16 MHz*
- *Includes SCSI interface and two RS-232C ports*

The CPU 20 single-board computer incorporates an MC68020 μP that features 32-bit-wide address and data paths. The μP is available with either a 12.5- or a 16-MHz clock rate. You can choose 1M or 4M bytes of onboard dynamic RAM. The dynamic RAM offers selectable parity checking with automatic retry logic. The board has a 1k-byte, dual-ported static-RAM mailbox with a jumper-selectable address range, and it includes a 1k-byte NOVRAM and a socket for 1M byte of EPROM. Interfaces on the board include one SCSI port, one 23-bit parallel port, and two RS-232C ports. A VME Bus interface supports 16-, 24-, and 32-bit-wide addresses, as well as a short I/O device on 16- or 32-bit-wide data. A priority-controlled bus arbiter with a round-robin option and an onboard requester with an RWD/ROR (release when done/release on request) option supports multiprocessor functions. Embedded diagnostic routines, a 4-digit alphanumeric display, and a system monitor provide start-up support. CPU 20 (12 MHz), $3890.

Dage Precision Industries Inc, Box 120A, Santa Clara, CA 95052. Phone (408) 727-1932.

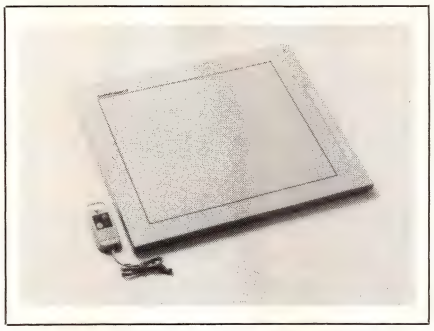
Circle No 376

DIGITIZER

- *Large-area digitizer tablet measures 13×16.5 in.*
- *Device includes a 4-button cursor puck*

The Grafnet-02 digitizer tablet has an active area of 13×16.5 in. and comes equipped with a 4-button cursor puck. You can use the tablet as a

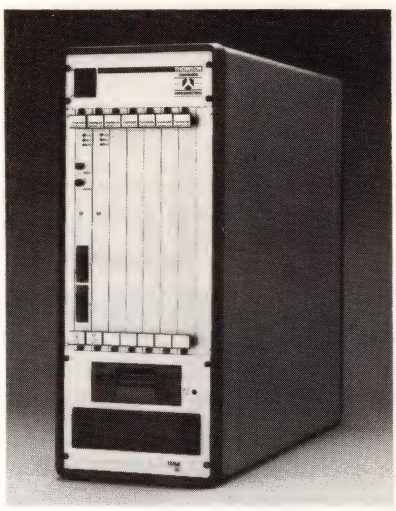
computer-graphics or CAD/CAE input device for tracing large drawings or for applications that require large-area "pick menu" overlays. The device has a wall-plug dc power supply and a 5-ft data cable that terminates in a D-9/F connector. You can use this connector with the serial port of an IBM PC/AT. A single-switch stylus is optional.



Electrostatic coupling between a grid in the tablet and the cursor or stylus allows you to digitize the X and Y coordinates of a point or a line with a resolution of 250 lpi and an absolute accuracy of ±0.02 in., anywhere on the active surface. An RS-232C interface provides data output. You can select the data format by means of DIP-switch settings or remote ASCII code. An Autodesk Device Interface driver, which facilitates the use of the digitizer tablet with the Autodesk's (Sausalito, CA) AutoCAD system, is available at no charge. $595.

Mitsubishi International Corp, 520 Madison Ave, New York, NY 10022. Phone (212) 605-2607.

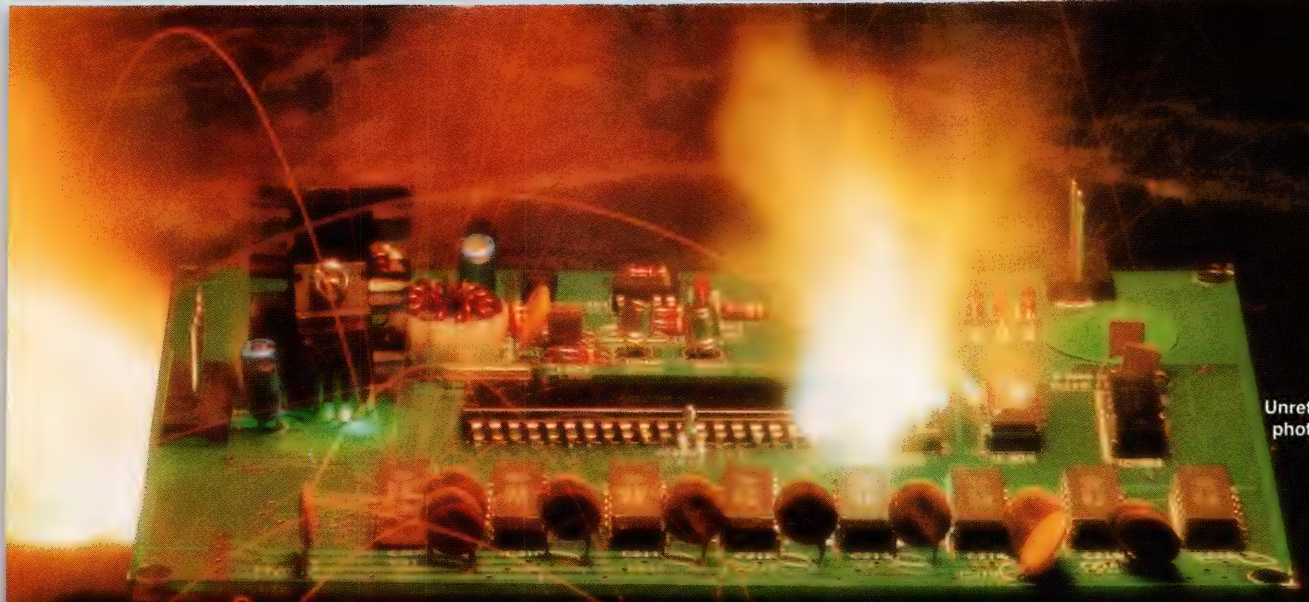
Circle No 377



COMPUTER

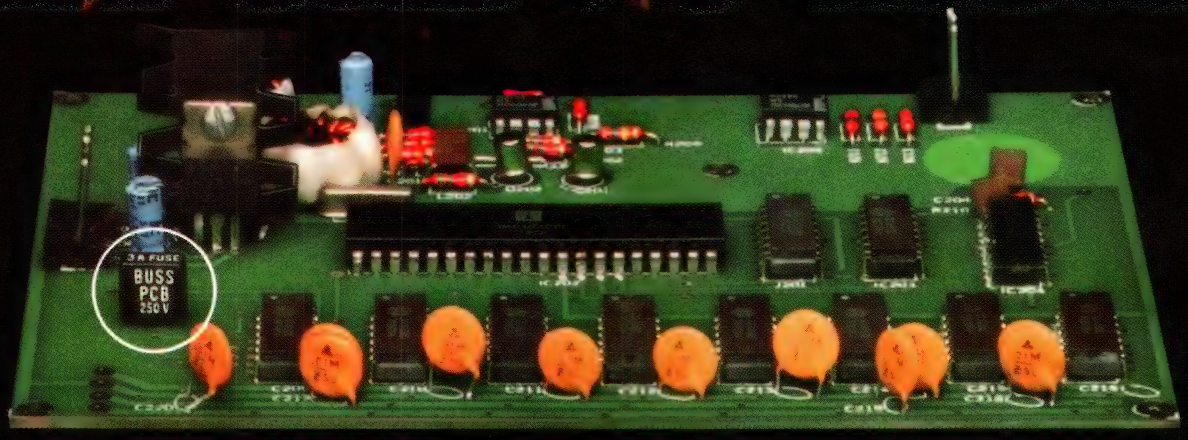
- *VME Bus computer has five slots for expansion*
- *Comes with Unix operating system on hard disk*

The TSVME 962 is a VME Bus-based computer that comes with Unix System V.2 (release 2.0) on its hard disk, and an 8-user license. The computer includes a 10-MHz 68010 CPU and 2M bytes of dynamic RAM. It has a 3½-in. floppy-disk drive and a 5¼-in. hard-disk drive with formatted capacities of 720k bytes and 67M bytes, respectively. It also comes with a 60M-byte



Unretouched photograph

BEFORE PC-TRON®



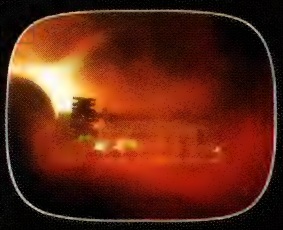
AFTER PC-TRON®

Finally, a fuse that protects the board, Bussmann current-limiting PC-Tron!

Before the Buss PC-Tron, fuses performed a limited function on printed circuit boards. They protected equipment against fault currents, but not the printed circuit board's components; transistors could explode, and traces might vaporize. Until now designers have had to live with these service costs and liability potentials. Now the new PC-Tron fuse greatly reduces these risks. Unlike glass-cartridge and other subminiature fuses, the PC-Tron is current-limiting. Its low let-through energy capability *protects the transistor and all board components.* With all that, the PC-Tron also reduces production costs significantly. It takes 89% less space than a glass-cartridge fuse and is automatically insertable, board washable and wave solderable.

SEE THE DOCUMENTARY VIDEO

See the PC-Tron fuse in action in a new videotape. See how it can help you to design in circuit protection never before possible and with production economies. For a showing write PC-Tron Videotape, Bussmann Division, Cooper Industries, Box 14460, St. Louis, MO 63178; phone (314) 394-BUSS.



COOPER INDUSTRIES

BUSSMANN

CIRCLE NO 129

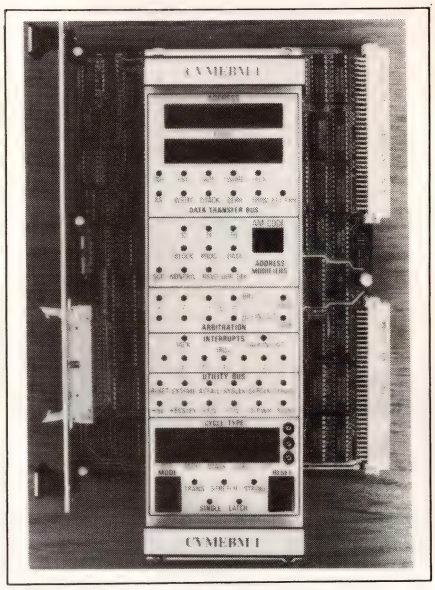
streaming-tape drive. Five VME Bus mother-board slots and excess power-supply capacity amounting to 18A at 5V are available for user expansion. The TSVME-962 is housed in a 4U, 19-in. fan-cooled cabinet. Programming languages, including Fortran-77 and C, and a macroassembler are supplied. Approximately Fr fr 90,000.

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Vélizy, France. Phone (1) 39469719. TLX 204780.

Circle No 378

Thomson Components-Mostek Corp, 7950 E Redfield Rd, Scottsdale, AZ 85260. Phone (602) 951-2900.

Circle No 383



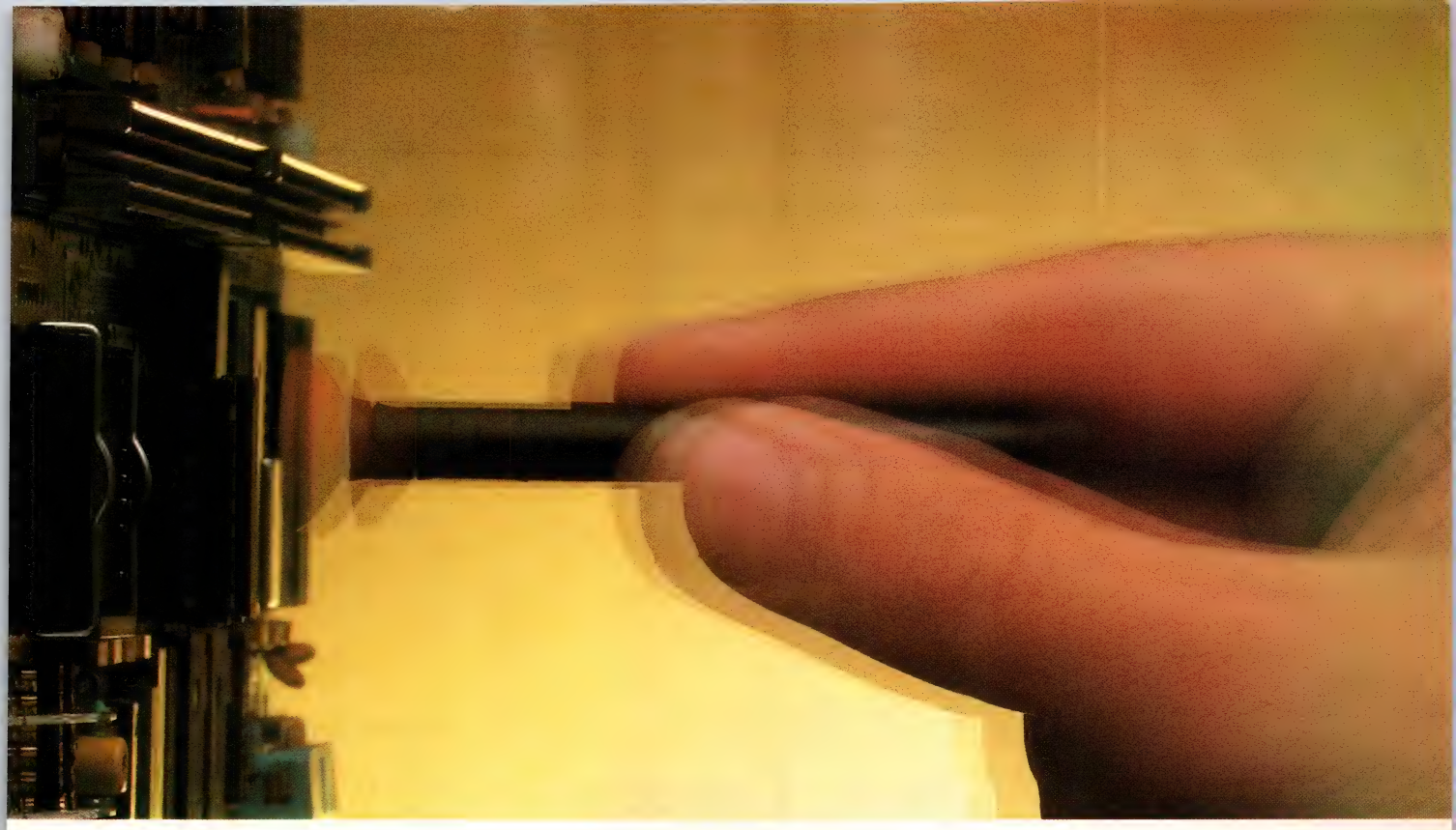
VME BUS MONITOR

- *Nonintrusively monitors all VME Bus signal lines*
- *Captures and identifies all types of VME Bus data transfer*

To assist in troubleshooting VME Bus systems, the CVMEBM1 nonintrusively monitors 32-bit VME Bus addresses and data transfers, as well as the states of all the VME Bus clock and control lines. Occupying one VME Bus slot, the monitor can intercept all types of bus cycle, including address pipelines, block transfers, unaligned transfers, and address-only cycles. In addition, it decodes the VME Bus address-modifier lines, and you can use other bus signals—for example, DTACK, BERR, and IACK—or an external signal to qualify the bus cycle. LED and hexadecimal displays on a separate module indicate bus address-, data-, and control-line status. This module links to the monitor board via ribbon cable. The number of hexadecimal digits displayed for the VME Bus address and data automatically adjusts to the type of data transfer in progress. The CVMEBM1 conforms to the Rev C.1 VME Bus standard. $3000.

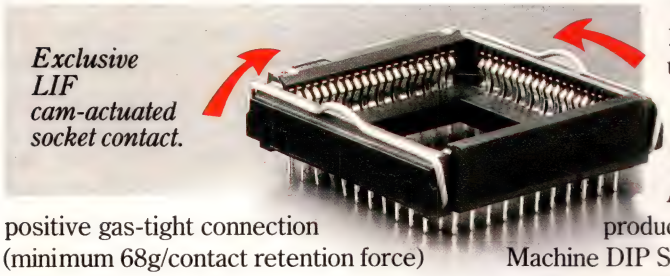
Concise Technology, 227A Aylesbury Rd, Bierton, Aylesbury, Bucks HP22 5DS, UK. Phone (0296) 81483.

Circle No 379



THOMAS & BETTS TAKES THE PRESSURE OFF CHIP DAMAGE.

Easier chip carrier socket insertion/extraction cycles shouldn't occur at the expense of possible chip damage from too much insertion/extraction force pressure. Our unique Ansley® Plastic Chip Carrier Socket with its exclusive cam-actuated socket contact design provides a positive gas-tight connection (minimum 68g/contact retention force) at a low 50g/contact maximum insertion/extraction force — perfect for VLSI and high density applications.



Exclusive LIF cam-actuated socket contact.

The socket's polarizing feature assures positive chip carrier orientation, and the socket can be installed on PC boards without special tooling.

The Ansley® cam-actuated LIF PLCC is available in four sizes (44, 52, 68 and 84 positions on .050″ centers) in through-hole mount contact style. Sockets feature phosphor bronze contacts with tin/lead plated leads on .100″ sq. grid patterns.

When the job has to get done fast, *and with a minimum of risk and unnecessary cost,* take the pressure off yourself as well as your chip, depend upon the T&B Electronics Division to provide the means. Additional Ansley® socket products include Screw-Machine DIP Sockets, Pin Grid Array Sockets, IC Sockets with built-in decoupling capacitor circuits, and Stacked- DIP Sockets.

For more information, write or call Thomas & Betts Corporation Electronics Division, 920 Route 202, Raritan, NJ 08869; 201-469-4000.

Thomas&Betts
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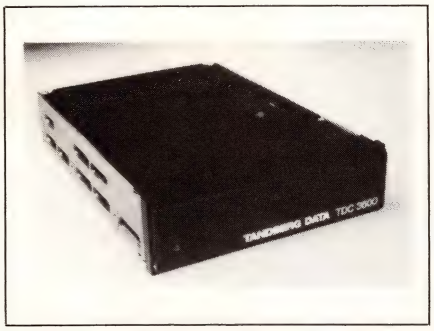
Other quality Thomas & Betts products include: *IDC Cable and Connector Systems, DIP & VLSI Sockets, Fiber Optic Systems, Flexible Interconnects, Two-piece Connectors and Multi-Pin Connectors.*

See us at Electro Booth 2304

CIRCLE NO 190



TAPE DRIVES

- *¼-in. streaming-tape drive*
- *Drives are available in 60M- or 125M-byte capacities*

The Tandberg TDC 3600 Series tape drives offer 60M-byte (Models 3610 and 3620) or 125M-byte (Models 3630 and 3640) capacities. The drives are half-height, 5¼-in.-format, SCSI or QIC-02 devices that consume 2.25W in standby mode and 14.75W while running. Data transfers take place at 1.45M byte/sec peak and 88k byte/sec avg. Each drive provides a 16k-byte buffer with programmable buffer thresholds, a built-in formatter, 9 or 15 tracks, and an 8000- or 10,000-bpi recording density. $525 to $740.

Siemens Information Systems Inc, 5500 Broken Sound Blvd, Boca Raton, FL 33431. Phone (305) 994-8800.

Circle No 381

COLOR DISPLAY

- *Ruggedized for military applications*
- *Capable of displaying various colors*

Suitable for use in equipment such as sonar and military data displays, which have to operate in severe environments, this 15-in.×625-line color display uses a 2-color liquid-crystal shutter positioned in front of its CRT to generate a variety of display colors. Although the liquid-crystal shutter can switch between only red and green, you can generate intermediate colors such as yellow and orange by using color-mixing techniques. The liquid-crystal shutter and an appropriate video signal switch at the CRT's frame rate to produce a flicker-free display. Because the CRT is a single-gun device without a shadow mask, the display is rugged and exhibits neither the color aberrations that arise from magnetic influences nor the breakup of fine detail associated with multiple-gun, shadow-mask CRTs. Two cross-polarized elements in the liquid-crystal shutter ensure that the display background is inherently dark. £10,000.

Ferranti Computer Systems, Cheadle Heath Div, Bird Hall Lane, Cheadle Heath, Stockport, Cheshire SK3 0XQ, UK. Phone 061-428 0771. TLX 666803.

Circle No 384

Reducing your product costs could be as simple as pushing the right buttons.

How can a little thing like a MICRO SWITCH pushbutton lower the cost of making your product? Dozens of ways.

We can add, subtract, or redesign our standard pushbutton features to eliminate manufacturing steps. Reduce inventory requirements. Or lower component costs.

Sometimes it's as simple as leaving out features like audible feedback or UL listing when they're not needed.

Or it can get as involved as supplying a finished subassembly with custom-molded buttons, legended faceplate, keylock, PC board, and LEDs.

When it comes to saving you money without sacrificing product performance, we can be very flexible.

To learn more about how we can work with you to reduce total costs, or improve product performance or appearance, ask for our new brochure. Call us at 815-235-6600, ext. 610. Or write MICRO SWITCH, Freeport, IL 61032.

Together, we can find the answers.

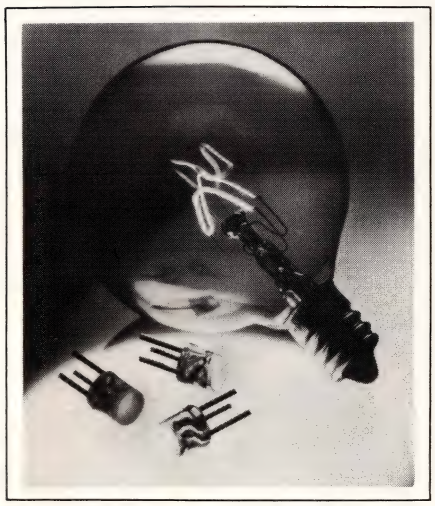
MICRO SWITCH
a Honeywell Division

Stop by and Visit us at Booth #1951 during Electro, NY

CIRCLE NO 157

NEW PRODUCTS

COMPONENTS & POWER SUPPLIES



LED LAMPS

- *Replace incandescent lamps*
- *5×10^6-hour min MTBF*

For backlighting applications, HLMP-AXXX Series LED lamps are an alternative to small incandescent lamps. Each lamp contains four LED chips and provides a viewing angle of 120°. The MTBF specs in excess of 5×10^6 hours min. Power consumption is low; with a forward current of 50 mA, typical forward-voltage specifications vary from 4.2 to 4.6V. Three colors are available —high-efficiency red (HLMP-A200), yellow (HLMP-A300), and high-performance green (HLMP-A500). The devices have a 3-lead configuration—a cathode, an anode, and a center heat sink. $0.99 (Over 5000).

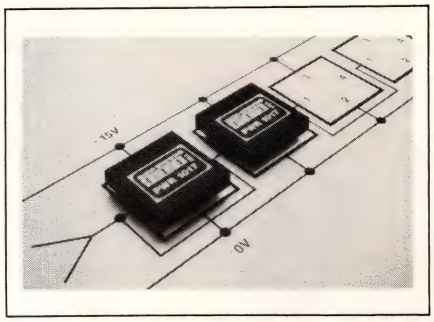
Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 414

DC/DC CONVERTER

- *10 to 18V dc input range*
- *1000V I/O isolation*

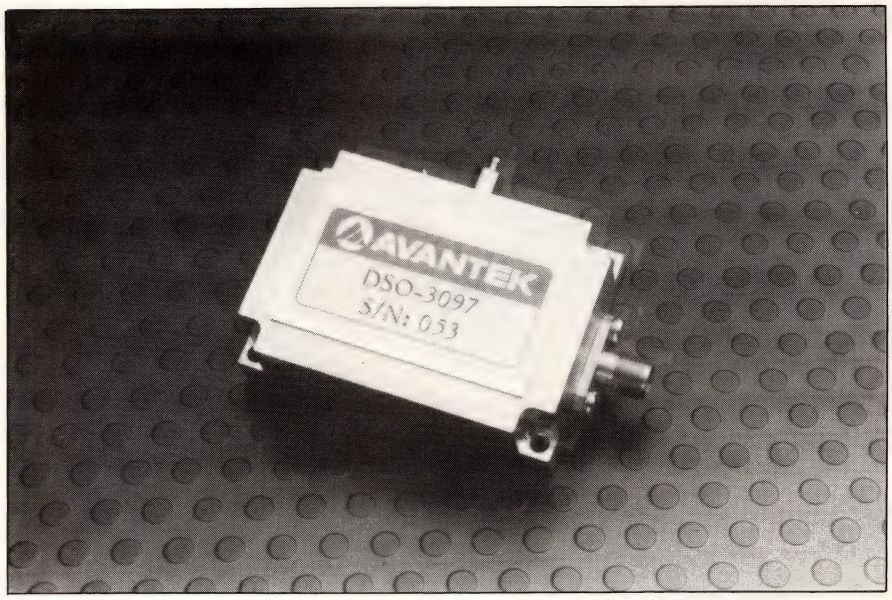
The PWR1017 is a 4-channel, dual-output, unregulated dc/dc converter. It features a master/slave design to eliminate beat-frequency noise generated by multiple supplies in the same system. When using multiple PWR1017s, you hook the slave pins to the master pin on one unit, thus synchronizing all switching frequencies to the master converter. You can also drive the converters from an external clock. An input of 400 to 750 kHz drives the converters at a 200- to 350-kHz switching rate. The free-running switching frequency (no slave pins used) equals 250 kHz. The converters operate over a 10 to 18V dc input range; the output of each channnel equals ±15V at 25 mA. The maximum output power is 3W. Isolation between each output and from the input



equals 1000V pk. Other key features include 6-sided shielding, input and output filtering, and a low-profile 0.4-in.-high package. $58.75 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 415



OSCILLATORS

- *Feature an 8- to 18-GHz frequency range*
- *10-mW min output power*

DSO-3000 Series dielectrically stabilized oscillators offer customer-selectable frequencies ranging from 8 to 18 GHz. Specifications include a typical harmonic suppression that is 30 dB below the carrier, spurious outputs that are 60 dB min below the carrier, and typical single-sideband phase noise that's 90 dB below the carrier. The minimum output power specs at 10 mW. All specs are guaranteed from −54 to +85°C. Power requirements equal 100 mA at 15V. The oscillators are packaged in aluminum cases that include SMA connectors. From $900.

Avantek Inc, 3175 Bowers Ave, Santa Clara, CA 95054. Phone (408) 970-2156.

Circle No 416

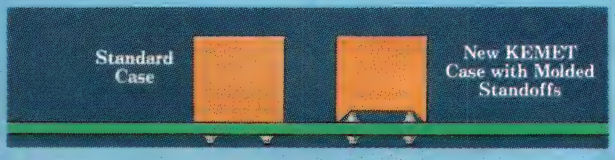
WS6536E SOLUTION: KEMET® Is The Source.

Higher Production. Improved Solderability. Easier Inspection. Same Compact CKR06 Size!

Meeting tough specs like WS6536E (weapons) and DoD 2000 is as easy as saying KEMET®.

Our revolutionary new-design CKR06 molded ceramic capacitor solves some knotty soldering and inspection problems that may have been making military circuits a headache for you.

It features an imaginative molded-in standoff that improves solder flow around the pre-tinned radial leads. And lets you easily inspect the critical solder fillet between circuit board and component case. So you get higher production yields with assured reliability.



The new KEMET CKR06 meets all applicable requirements of MIL-C-39014/02 for military components, yet maintains the same overall dimensions as standard units (.300" x .300" x .100"). The result: better solderability performance and greater productivity, without increasing board space.

Improve your component on-board placement costs, starting now. Ask for specs, pricing and engineering samples of our new CKR06 capacitor. KEMET helps you get down to business.

Sales Offices and Distributors Worldwide.
In U.S.A: (803) 963-6348; Telex 57-0496.
In Europe: 41-22-396512; Telex 845-911302.
In Asia: 852-372-31211; Telex 780-45162.

UNION CARBIDE ELECTRONICS DIVISION COMPONENTS DEPARTMENT

Order KEMET

CIRCLE NO 192

EXPANSION CHASSIS

- *Easy removal of subsystems for maintenance*
- *LEDs indicate drive status*

The SA-H157 peripheral chassis supports two 8-in. Winchester-disk drives (Priam Models 806, 807, and 808) and includes power and data cables and rear I/O cable connections for the drives. The unit features convenient drive installation and removal, drive cables, and easy power-supply removal for maintenance and troubleshooting. The 400W power supply provides 5V dc at 8A and 24V dc at 9A. The power-supply enclosure includes two fans. The front console provides drive-0/drive-1 selection information and contains LED indicators for drive status. $1250.

Sigma Information Systems, 3401 E La Palma Ave, Anaheim, CA 92806. Phone (714) 630-6553. TLX 298607.

Circle No 417

CABINET COOLER

- *Fits outside the cabinet for maximum design flexibility*
- *Removes 600W of heat*

The CC400F compact cabinet cooler is designed to mount outside the cabinet. While it cools the cabinet's internal equipment, it isolates the electronics from moisture and the airborne dust, oil, and dirt found in many industrial environments. The cooler's two fans are the only moving parts, so power requirements are held to 30W (15W per fan). The 11-lb cooler measures 22×5.5×4 in. It removes 600W of heat from the

cabinet interior while holding increases in temperature to 20°C above ambient. Standard units operate from 115 or 230V ac (50/60 Hz). $470 (50).

Noren Products Inc, 3543 Haven Ave, Menlo Park, CA 94025. Phone (415) 365-0632.

Circle No 418

If you made 'zero defect' card readers, wouldn't you offer the best warranty in the business?

A company can offer an outstanding warranty when the likelihood of using it is similar to the product's defect record. Zero.

That happens to be the case with American Magnetics' card readers. And for some very good reasons.

First and most important, we don't sample test. We test everything, 100% of our card readers—approaching one million units in the field. What's more, we make the most important component in the reader—the magnetic head—instead of buying it. That gives us complete quality control, and gives each reader a minimum life of over 1 million passes.

Now here are some other good reasons for choosing from a variety of our swipe insert or motorized card readers. They're system friendly ■ They all but eliminate software development ■ They have resident buffer or real time data transmission ■ They come in compact table top or "built in" versions ■ They accept 115 VAC or 5 VDC power ■ They have patented Spatial Decoding for high reliability read.

Oh yes, one other thing. They come with the best warranty in the business.

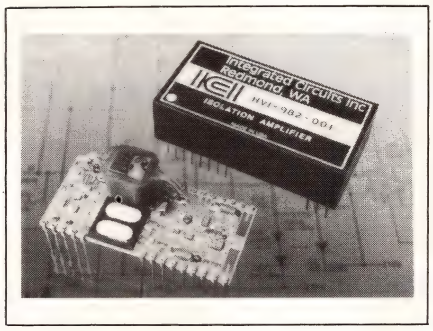
36 MONTH WARRANTY **Every American Magnetics card reader comes with either an 18 MONTH or a 36 MONTH warranty. Period.**

American Magnetics Corporation

740 Watsoncenter Road, Carson, CA 90745
Telephone (213) 775-8651

AMERICAN MAGNETICS CORPORATION

CIRCLE NO 206



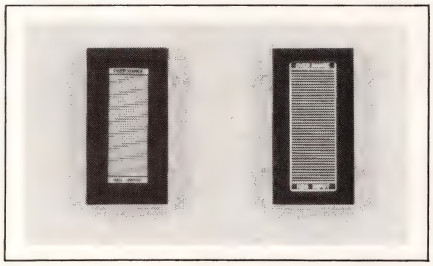
ISOLATION AMP

- *Features 140-dB CMR*
- *Isolation of 10 kV pulsed*

The HVI-982-001 incorporates a 2-stage amplifier and an onboard dc/dc converter. Designed for medical applications, it features a 140-dB CMR, 0.1% max nonlinearity, a wide gain-bandwidth product (gain of 100 at 15 kHz), active guard drive, dc restoration circuitry, 5 μV/°C input-offset voltage drift, and provisions for I/O offset nulling. A proprietary optocoupler provides isolations of 10 kV pulsed or 7 kV continuous. The unit meets the UL 544 standard. Differential inputs are protected to 305V rms for 3 sec. The dc/dc converter powers the first-stage amplifier and also provides a ±15V/30-mA output. Housed in a 25-pin epoxy potted DIP, the amplifier operates over 0 to 70°C. $131 (100). Delivery, stock to 12 weeks ARO.

Integrated Circuits Inc, 10301 Willows Rd, Redmond, WA 98052. Phone (206) 882-3100. TWX 910-443-2302.

Circle No 419



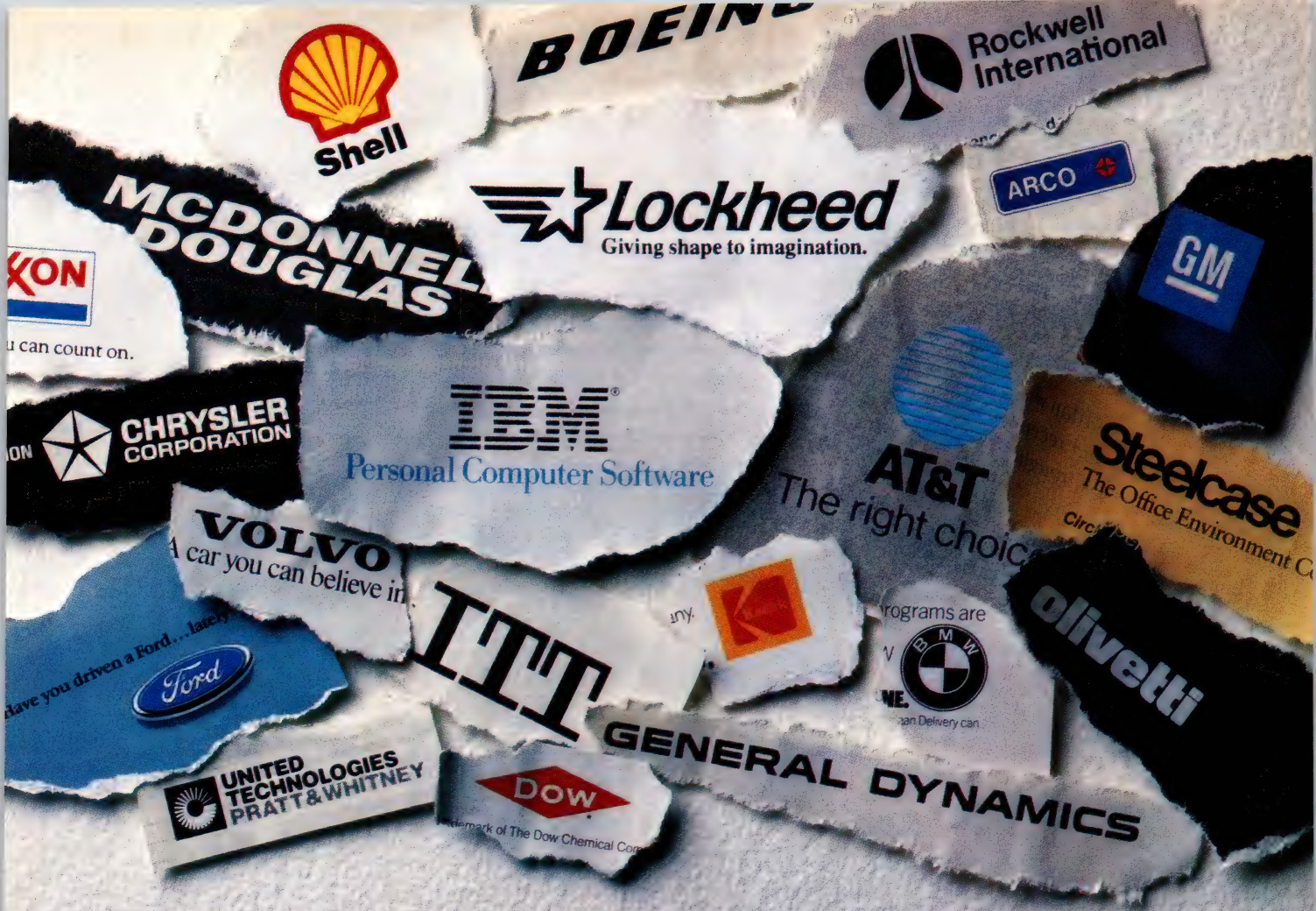
BAR-GRAPH METER

- *Offers 2.5% resolution*
- *Has two full-scale voltage ranges*

Model IDA-0250-1X42-1 is a liquid-crystal bar-graph panel meter. It features variable LED backlighting to improve visibility under various lighting conditions and to enhance the viewing angle. The unit has 40 bars (2.5% resolution) plus a zero bar, overrange and negative-input flags, and 1.1-mW power consumption (excluding backlighting) from a 9V supply. The variable LED backlighting operates from 5V and draws 180 mA. Two full-scale voltage ranges are available—0 to 2V and 0 to 200 mV. Featuring a 0.5-in. profile, the unit will accommodate either horizontal or vertical mounting. $120.

UCE Inc, 24 Fitch St, Norwalk, CT 06855. Phone (203) 838-7509.

Circle No 420



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Most companies know us for our solid reputation in pen plotters. Yet many leading corporations all around the world also know CalComp for electrostatic plotters. And they select CalComp for good reasons.

CalComp offers a full family of color and monochrome electrostatic plotters with high resolution image quality—up to 400 dots-per-inch. Our 5700 and 5800 series plotters are self-contained plotting systems without the need or expense of any add-on controllers.

Also, many Fortune 500 companies are already familiar with our high quality products, responsive sales support and worldwide field service network. After all, we've been in the computer graphics business for over 25 years.

So if you're shopping for the right electrostatic plotter, check the ones found in all the right places. Call 1-800-CALCOMP. Or write CalComp, P.O. Box 3250, Anaheim, California 92803.

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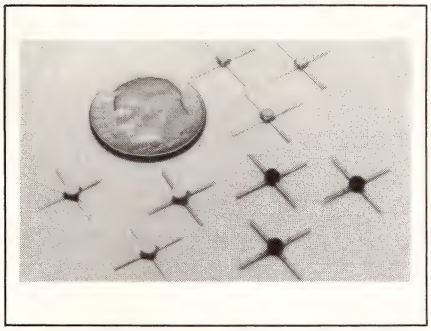


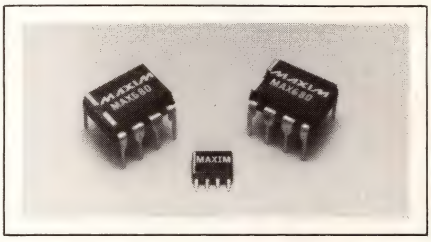
CONVERTERS

- *RF inputs range to 8 GHz*
- *Provide conversion gain*

MSF Series monolithic silicon converters provide up-or-down frequency conversion with as much as 20 dB of gain and RF inputs of 500 MHz to 8 GHz. They are built to operate simultaneously as a self-oscillating local oscillator (LO) and a 2-port active mixer. With a −20 dBm RF input at 4.2 GHz and a 5.15-GHz LO input, typical electrical specs include a conversion gain of 9 dB (to 950 MHz), a 1-dB compressed output power of 9 dBm, a third-order-output intercept point of 16 dBm, and an IF-band spurious-signal level of less than 70 dBc. The converters are available in packages that are suitable for industrial, military, and commercial applications. The MSF-8835, in a microstrip ceramic package, $12.40; the MSF-8870, in a 70-mil hermetically sealed metal-ceramic package, $29.75; and the MSF-8885, in an 85-mil plastic package, $5.20 (1000).

Avantek Inc, 3175 Bowers Ave, Santa Clara, CA 95054. Phone (408) 970-2659.

Circle No 421



VOLTAGE CONVERTER

- *Can achieve 99% conversion efficiency*
- *2 to 6V dc input range*

The MAX680 dual charge-pump voltage converter provides positive and negative voltages from a single positive supply. It features a conversion efficiency rate to 99% and power efficiency to 85%. The unit handles inputs of 2 to 6V dc and provides outputs of +2 V_{IN} and −2 V_{IN}. The output current ranges to 10 mA. Typical 10-mA-load output impedances range from 90Ω for the V^- output to 150Ω for the V^+ output. The quiescent-current level for a 5V input equals 1 mA. The converter can also function as a voltage quadrupler, producing a +12 or −12V output when operating from an isolated 3V source. The unit is

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An NMB Company

available in plastic or ceramic 8-pin DIPs, or in an 8-pin small-outline (SO) package. Three operating ranges are offered: 0 to 70°C, −40 to +85°C, and −55 to +125°C. $2.16 to $4.32 (100).

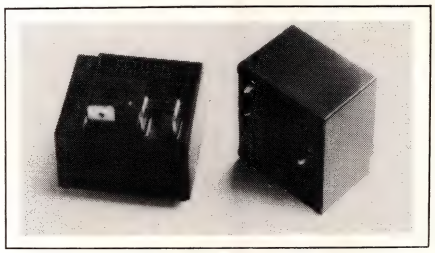
Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 422

POWER RELAY

- *Meets UL 508 and UL 873 spacing and contact requirements*
- *10-million-operation life*

The AZ 2160 switches as much as 30A. Featuring quick-connect terminals, it's available in versions that meet UL 508 and UL 873 spacing and contact requirements. The



relay has a life expectancy of 10 million operations, and it features class B insulation. A class F version is also available, and you can order the 2160 with an epoxy seal for compatibility with automatic wave soldering and immersion cleaning processes. The relays come with Form 1A, 1B, or 1C contacts; the coil voltage specs at 120V dc. Unsealed, Form 1A model, $1.70 (1000). Delivery, six to eight weeks ARO.

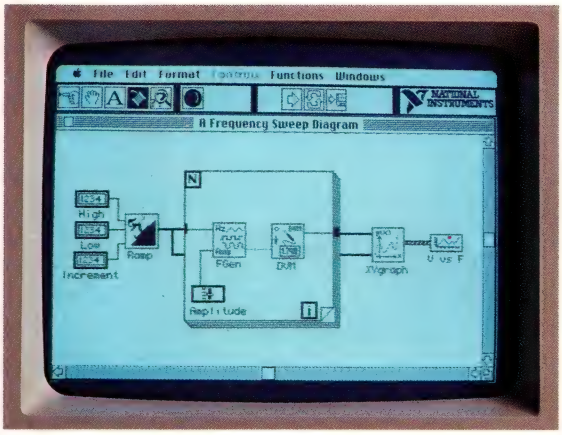
American Zettler, 16881 Hale Ave, Irvine, CA 92714. Phone (714) 660-1670.

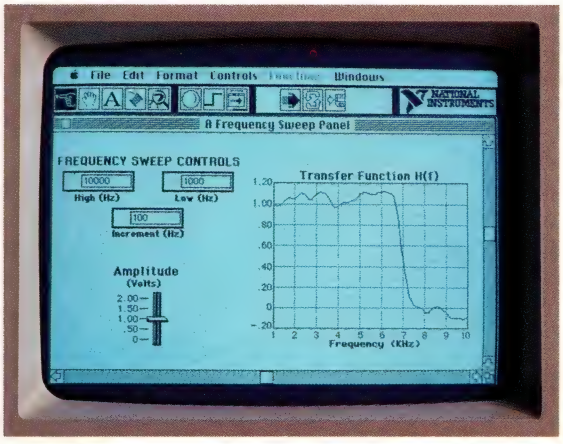
Circle No 423

SYNTHESIZER

- *Offers a range from 30 mHz to 30 MHz*
- *4-bit bus interfaces*

Housed in a 1.6×2.25-in. shielded package, the FS-30 is a complete frequency synthesizer. It includes a loop filter, a VCO, and divider registers. The only external component required is a crystal or clock oscillator. The output frequency spans 30 mHz to 30 MHz in 48 ranges (with more than 7500 steps per range). Resolution specs at 0.013%. The unit operates from a 5V supply and draws 120 mA. It accepts CMOS inputs and generates TTL or CMOS outputs. The unit features 3-state outputs and 4-bit bus interfaces to any μP. A kit (FS-30, pc board, regulators, control switches, and





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Developing scientific experiments takes creativity. Writing code to run them takes sweat. At least it used to.

But no longer. Because we've just solved the scientific and engineering programming problem.

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Picture the perfect programming language.
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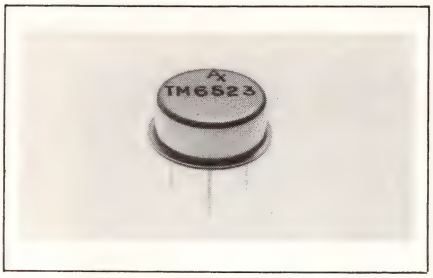
CIRCLE NO 159

tutorial matter) is available for designers new to frequency synthesis. The kit requires a 7 to 15V supply. FS-30, $195; kit, $295.

Analytic Instruments Corp, Box 20340, Dallas, TX 75220. Phone (214) 357-3882.

Circle No 424



RF AMPLIFIER

- *Specs a 25.5-dB typ gain*
- *Operates over −55 to +85°C*

Housed in a TO-8 hermetic package, the Model TM 6523 hybrid RF amplifier provides a gain of 25.5 dB typ over a frequency range of 5 to 500 MHz. Other specs include a 4.5-dB typ noise figure, 14-dBm power output at 1-dB compression, and 2:1 input and output VSWR. The amplifier operates over −55 to +85°C, and power requirements equal 75 mA at 15V. $95.

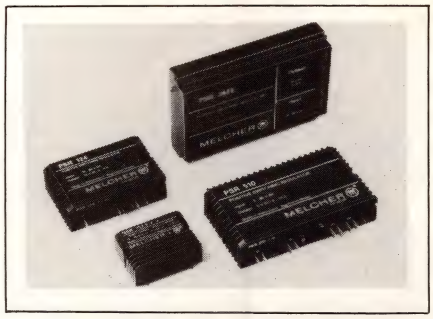
Amplifonix Inc, 2010 Cabot Blvd, West Langhorne, PA 19047. Phone (215) 757-9600.

Circle No 425

REGULATORS

- *Feature efficiencies to 94%*
- *150-kHz switching frequency*

The PSR/PSN Series of positive and negative switching regulators consists of 18 models. Available outputs include 5V dc at 3 to 12A as well as 12, 15, 24, or 36V dc at 2.5, 4, or 8A. The units use power FETs to develop a 150-kHz switching frequency.



The input-voltage range specs at 8 to 80V dc (PSR 53-7), and the efficiency rate reaches 94%. The operating range without derating spans −40 to +71°C (higher temperatures are available if the case temperature remains below 95°C). Available options include output and input undervoltage monitors, an adjustable output voltage, an inhibit terminal, and a thyristor crowbar circuit. $90 to $320.

Melcher Inc, 10 Cochituate Rd, Natick, MA 01760. Phone (617) 653-9979.

Circle No 426

Now for the First Time...

Affordable, High-Speed Custom Waveforms at your fingertips!

Introducing LeCroy's Model 9100 200 Mpoints/sec Arbitrary Function Generator

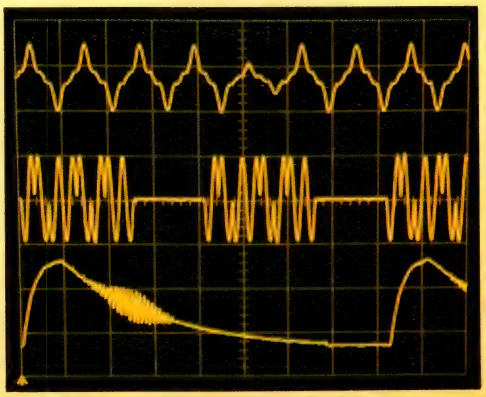
- **Custom Waves at 5 nsec/point**
- **Pulses & Square Waves to 100 MHz**
- **Dual Channel**
- **10 V p-p Output**
- **Risetime <4 nsec**
- **Long Memory**
- **EASYWAVE™ Software**
- **GPIB, RS-232 and Local Control**

High-Speed Custom Waveforms

Until now, custom waveforms have been relegated to low frequency applications. That has changed. With LeCroy's new Model 9100, custom waveforms of up to 200 megapoints/sec (5 nsec/point) can be generated. Standard function generators are becoming obsolete.

Why Custom Waveforms?

A signal source should simulate a "real world" waveform. In the past, only sine waves, square waves, ramps or pulses were available for high speed applications. But using these limited waveforms, how could circuits be tested under actual conditions? Such as testing a threshold detector by varying the amplitude of a single pulse out of a hundred? Or a phase detector by varying the phase of one cycle out of a thousand? Or test an equipment setup with a replica of an actual waveform? All too often, this kind of testing wasn't done at all or was extremely hard to do. But now the LeCroy 9100 solves all these problems and many, many more.



"Real World "Waveforms: Disk Head (top), PSK ASC II "k" (middle) Flourescence Decay (bottom)

It's Easy

Creating new waveforms is easy with LeCroy's Optional EASYWAVE™ software package designed for use with the IBM PC™ and most compatibles. Simply select some basic shapes from a library, add them together, and then stretch them to the amplitude and time duration that you desire. Or acquire "real world" waveforms with LeCroy digitizers and digital oscilloscopes.

It's Affordable

The LeCroy Model 9100 frees you from the limitations of standard function generators and, at less than $9,000*, it won't wreck your budget. For that price you get waveform linking, channel summing, 8-bits resolution, 12-bits dynamic range, 64 kpoints fast memory, 350 kpoints of non-volatile waveform storage, six standard waveforms.

Start improving your design and product quality with high-speed, custom waveforms using the LeCroy 9100 AFG. For more information circle the reader service number or call us at: 914-425-2000 for a demonstration.

*USA price only

See us at Electro/87 Booths 2508-2514

Circle no. 9 for Information

LeCroy

700 South Main Street, Spring Valley, NY 10977, USA. Tel: (914) 425-2000
Route du Nant-d'Avril 101, 1217 Meyrin 1-Geneva, Switzerland. Tel: (022) 82 33 55

For information on employment opportunities at Le Croy, see our ad in the recruitment section.

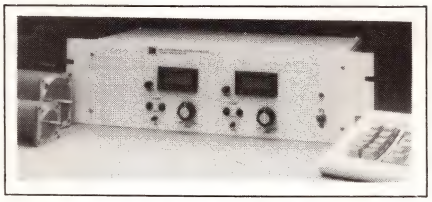
POWER TRANSISTORS

- *Collector currents of 50A*
- *0.35-μsec max rise time*

The 2N6274 and 2N6277 power-switching transistors are available as JAN, JANTX, and JANTXV devices per MIL-STD-19500/586. The devices are also available (in high volume) for commercial-grade levels. V_{CEO} equals 100V for the 6274 and 150V for the 6277. Both devices feature a continuous collector-current rating of 50A, a maximum rise time of 0.35 μsec, and a fall time of 0.25 μsec. The units are housed in a modified TO-3 package, dissipate 250W, and operate over a junction temperature range of −65 to +200°C. Military versions of the 2N6274, $16.95 to $27.20; military versions of the 2N6277, $27.50 to $40.75; commercial versions of each, $10 and $19.10 (100), respectively.

General Semiconductor Industries Inc, Box 3078, Tempe, AZ 85281. Phone (602) 968-3101. TWX 910-950-1942.

Circle No 429



MOTOR CONTROLLER

- *3000-step/sec slewing rates*
- *Simplifies computer interfacing*

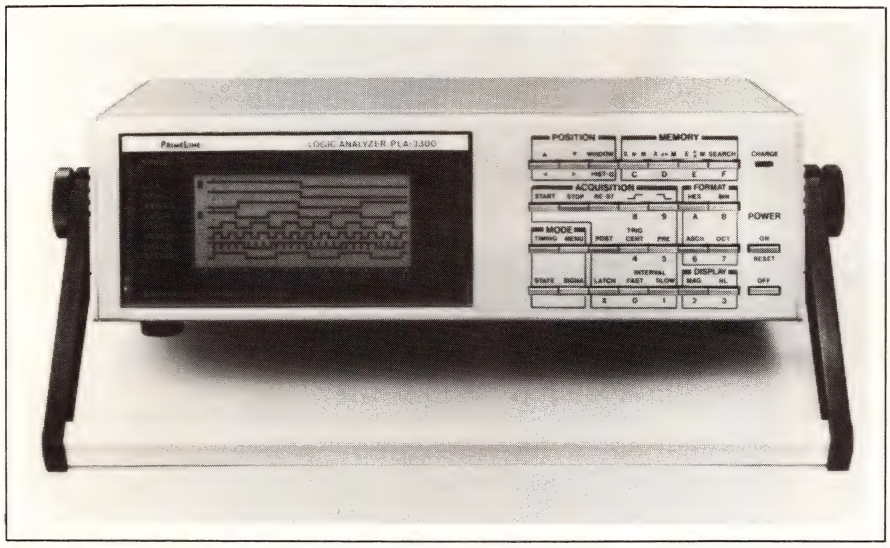
The SMC-202B stepping-motor controller has a built-in chopper drive that provides a 3000-step/sec slewing rates. A 16-bit μP provides intelligent motion control, which includes acceleration/deceleration ramping, stored program control (4000 bytes), relative and absolute positioning, and automatic backlash compensation. A built-in RS-232C port and an optional IEEE-488 bus simplify interfacing to computers, controllers, and terminals. User-friendly programming commands feature single-letter mnemonic codes. Manual control features include a front-panel toggle switch to run the motors, a front-panel speed control to adjust the stepping rate, and an optional joystick control to provide remote manual control of the two axes. Options include trackball or mouse input, encoder feedback for closed-loop operation, nonvolatile memory for program retention during power loss, and thumbwheel indexer control. The unit comes in a rack cabinet complete with power supplies, motor drives, and a built-in RS-232C interface. $1435 and $1675 for 1- and 2-axis models, respectively.

Maxwell Electronics Inc, Box 12033, Research Triangle Park, NC 27709. Phone (800) 922-0460; in NC, (919) 846-1633.

Circle No 430

NEW PRODUCTS

TEST & MEASUREMENT INSTRUMENTS



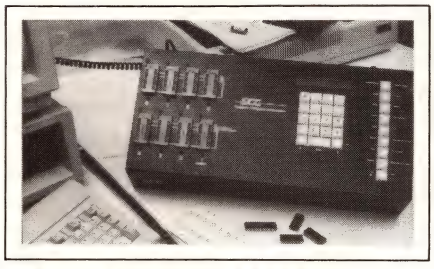
LOGIC ANALYZER

- *Runs at clock rates to 10 MHz*
- *Has 16 channels*

The PLA-3300 portable logic analyzer has 16 channels and runs at clock rates as high as 10 MHz. The analyzer is the size of a briefcase and is battery powered. Each channel has a 256-bit-deep memory. The instrument also has 15-nsec glitch-capture capability. The unit's LCD shows state, timing, or signature displays. $1995.

PrimeLine, Box 670, San Fernando, CA 91341. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

Circle No 385



GANG PROGRAMMER

- *Programs eight devices at once*
- *Handles 1M-bit EEPROMS packaged in DIPs and LCCs*

The SCC-512B can program a gang of eight devices at once. It can also produce a set of eight devices. In addition, the programmer can print labels on a printer via its built-in serial printer port. The unit has a hex keypad, dedicated function keys, and an LCD. It has a standard 16k-byte memory that's expandable to 256k bytes. $1195.

Southern Computer Corp, 141 W Wieuca Rd, Suite 300-B, Atlanta, GA 30342. Phone (404) 252-3340.

Circle No 386

COUNTER

- *Optional mathematically compensated crystal reference*
- *Variable trigger level for frequency/period measurement*

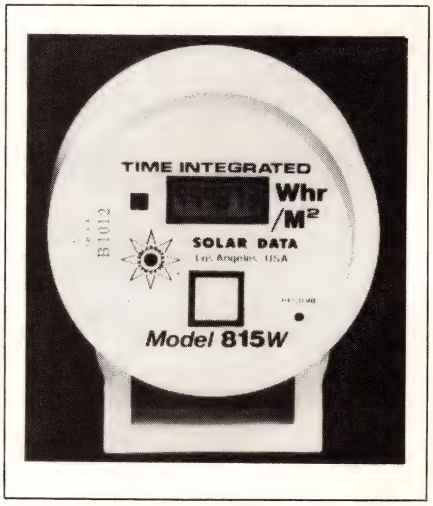
The PM 6665 is a 2-channel counter/timer with an input range of 0.1 Hz to 120 MHz and a timing resolution of 100 nsec in single-shot mode, or better than 20 psec in averaging mode. The frequency resolution amounts to a minimum of seven digits for a 1-sec measurement time. You can add a third input channel with 1.1-GHz frequency capability, and you can add a mathematically compensated crystal timebase, which improves the instrument's basic temperature drift over 0 to 50°C from 10 to 0.2 ppm. The two main input channels have variable sensitivity control for frequency measurements, and variable trigger-level control over ±5 or ±50V input ranges for time measurements. Additional functions include channel A/B ratio measurements, time interval A−B, totalize, and rpm display. An IEEE-488 interface, a battery pack, and a rack-mounting kit are optional. Approximately Gld 2500.

Philips, Industrial & Electro-acoustic Systems Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 387

Philips Test and Measuring Instruments Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 388



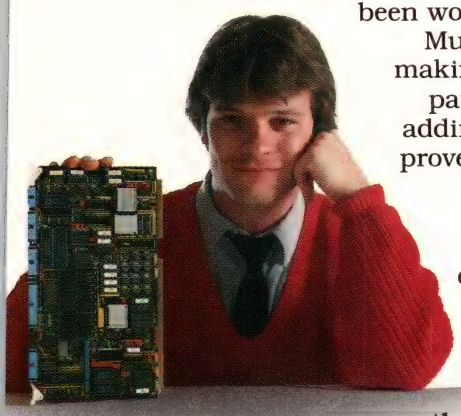
PYRANOMETER

- *Both measures and operates from solar power*
- *Instrument is sensitive to wavelengths of 350 to 1100 nm*

Model 815W, an integrating pyranometer, measures accumulated solar energy (Whr/m²). The 1-lb unit is entirely self-contained, and it oper-

"It's expanded as small as it can get."

That's what he said. And he was right. You see, our SBC design engineer, Tom Murphy, was convinced he could come up with a better board than Intel's 286/12. For months he'd been working with our new Multibus* 80286 SBC, making sure it was compatible with Intel, but adding refinements, improvements and putting more capabilities onboard. But more wasn't enough for Tom, he wanted less, too.



"There's gotta be a way to pack all these capabilities on to a board that only takes up one slot."

And that's just what he did. Our 80286 uses the latest in surface-mount and RAM packaging, putting it all onboard . . . not on top. That skinnied it up right there. But Tom wasn't satisfied. He put four serial I/O ports onboard ("Intel has two, so we'll double it," he said). That means no more expansion modules, less bulk and less cost.

And what about DMA channel capabilities? Well, Tom feels pretty smug about **that** enhancement. Starting with full duplex DMA for two serial ports, he added multiplexed channels . . . eight to be exact. (Don't even bother to look for any on their board). So all four serial ports are serviced with three DMA channels left open. Open for whatever **your** creativity demands.

Tom came up with other great ideas, all of which are in our brochure, but think about what you can do with just what we've mentioned.

Then think about picking up the phone. Call Mike Heins, SBC Product Manager at 1-800-482-0315. It's toll free. (In Illinois, call 217-359-8010). Ask him to send you a brochure, give you specs and prices or, if you like, he'll even connect you directly to Tom.

Or write us, Central Data, 1602 Newton Drive, Champaign, IL 61821-1098.

Multibus is a trademark of Intel Corporation.

Central Data

ates from solar power. It can accumulate data over periods ranging from minutes to months. The instrument covers wavelengths of 350 to 1100 nm and is accurate to ±3% min. $355.

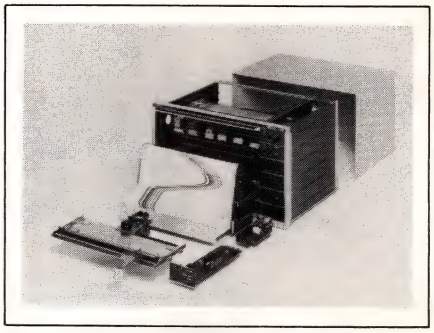
Solar Data, 4428 Franklin Ave, Los Angeles, CA 90027. Phone (213) 668-2001.

Circle No 389

RECORDERS

- *Record voltage, current, resistance, and temperature*
- *Employ felt-tip pens available in eight colors*

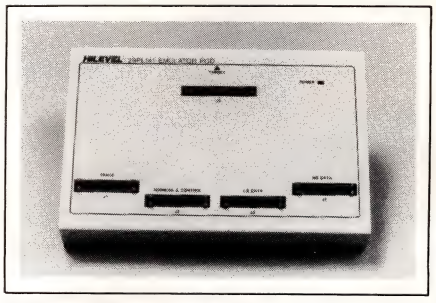
The 3310 Series 1- to 8-pen strip-chart recorders come in rack-mount and benchtop versions. All the pen mechanisms are interchangeable.



You can obtain a range of interchangeable plug-ins for dc voltage, dc current, temperature, and resistance inputs. The mainframes come in 2-channel, 4-channel, 6-channel, and 8-channel models. The recorders offer such options as X-Y operation and a 12-channel multipoint scanner that feeds one to four pen channels. Their accuracy is 0.25% of full scale. The units provide bidirectional chart speeds that have 16 ranges. The recorders use felt-tip pens, which are available in eight colors. From $2000.

Soltec Corp, Sol Vista Park, San Fernando, CA 91340. Phone (800) 423-2344; in CA, (818) 767-0044. TLX 4943094.

Circle No 390



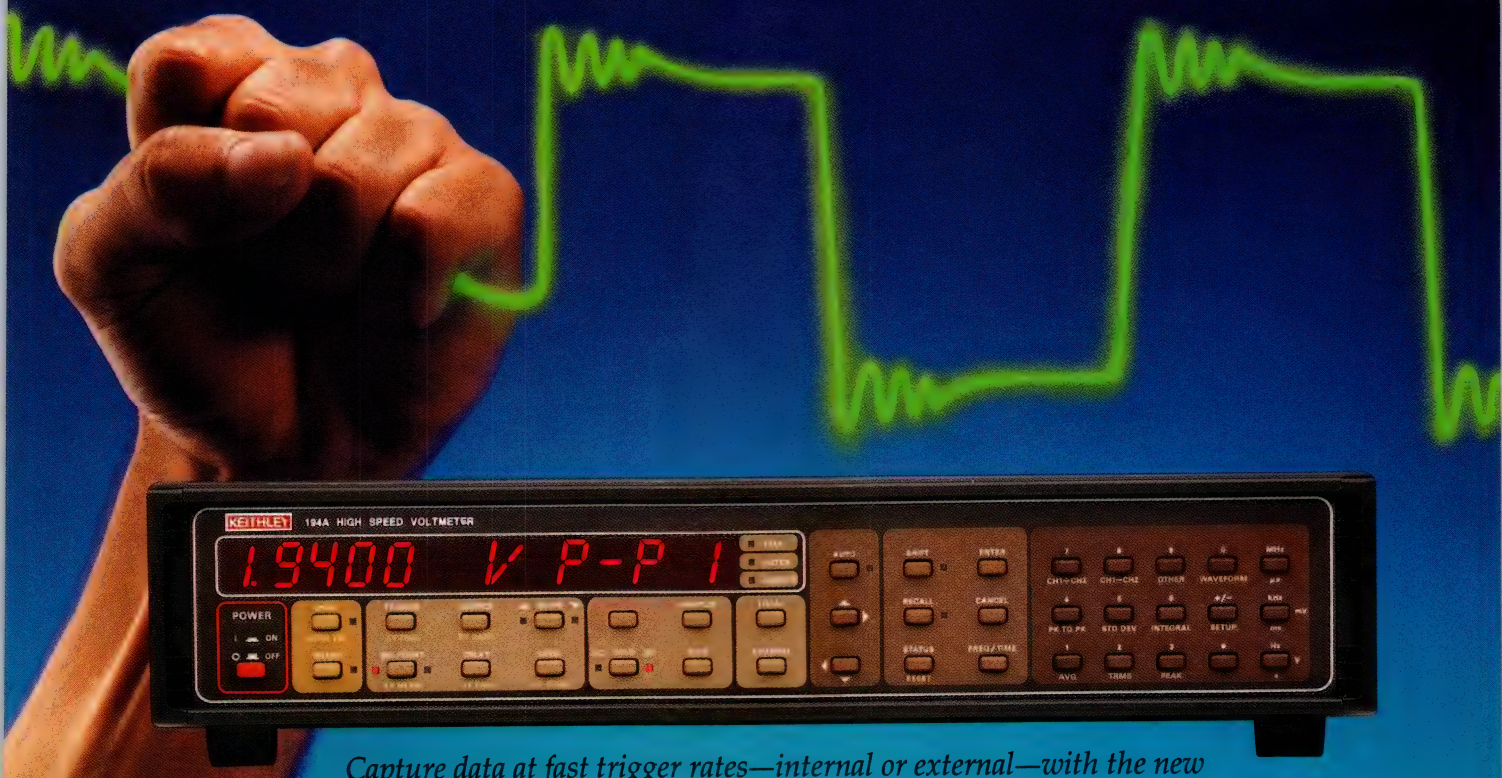
EMULATION POD

- *Provides access to internal registers and condition codes*
- *Runs at full speed of controller chip*

The EM29PL141 emulation pod substitutes for the AMD 29PL141 fuse-programmable controller in prototype circuits. The pod executes all of the 29PL141's instructions and runs at the full speed of the chip. The pod also gives you access to the chip's S and C registers, as well as its condition codes. With the aid of the pod,

NEW CAPABILITIES

CAPTURE IT



Capture data at fast trigger rates—internal or external—with the new Model 194A High Resolution Digitizer. Here are the advantages:

Faster, More Thorough Testing.

NOW—With the Model 194A High Speed Digitizer, you can acquire samples with external trigger pulses. Capture discrete samples synchronized to changes in position, distance, angle, log (time), a stimulus level, or other events. With trigger rates up to 1MHz, you can take more data in less time. That means more complete testing at lower cost.

Resolution of 16 bits. At rates up to 100kHz.

The Model 194A's 16-bit (4½-digit) resolution lets you detect 1 part in 32,000—far better than most digitizing devices. For higher frequency waveforms—up to 1MHz—the 194A samples with 8-bit resolution. And its 64k bytes of memory is up to 8 times that of other digitizers.

Add the 1944A Channel 2 option and acquire two different waveforms simultaneously, in time sync, or asynchronously. Each channel is independent, isolated, fully programmable, and has 64k bytes of memory.

The 194A provides 5 trigger options for initiating a measurement. Pre- and post-trigger data can be stored.

Analyze and Automate

The 194A directly displays key waveform parameters such as integration, RMS, average, and peak-peak. With two channels installed you can compute ratio or difference between channels.

All functions are IEEE-488 bus programmable. And our exclusive, built-in TRANSLATOR software reduces bus transfer time and simplifies documentation.

At **$4095**, you won't find better performance. And the optional second channel for just **$1995** doubles acquisition capability. For complete details contact the **Product Information Center, Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139, (216) 248-0400.**

KEITHLEY

CIRCLE NO 153

you can single-step your programs and capture selected data when the pod runs at full speed. The pod takes up four channels of the company's DS3700 bit-slice development system and works with the company's IBM PC software. $3000.

HiLevel Technology Inc, 18902 Bardeen, Irvine, CA 92715. Phone (800) 445-3835; in CA, (800) 752-5215. TLX 655316.

Circle No 391

FET TESTER

- *Checks 500V power MOSFETs*
- *Has 40A current capability*

The Stress-FET 100 handles power MOSFETs having voltage ratings to 500V. It has a 40A current capability. The tester can accommodate most standard packages, including TO-3, TO-220, and TO-218 packages. Three plug-in inductors—providing 100, 500, and 1000 μH—come with the tester. You can insert one of the inductors in series with the drain of the device under test. The instrument has a direct hookup to oscilloscopes, so you can see how your device breaks down under stress. $2395.

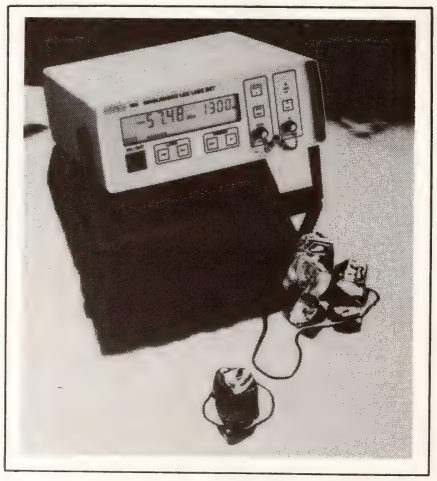
FET Test Inc, 8118 Main St, Garrettsville, OH 44231. Phone (216) 527-4000.

Circle No 392

OPTICAL METER/SOURCE

- *Combines light source and optical power meter*
- *Light source supplies −25 dBm single-mode power*

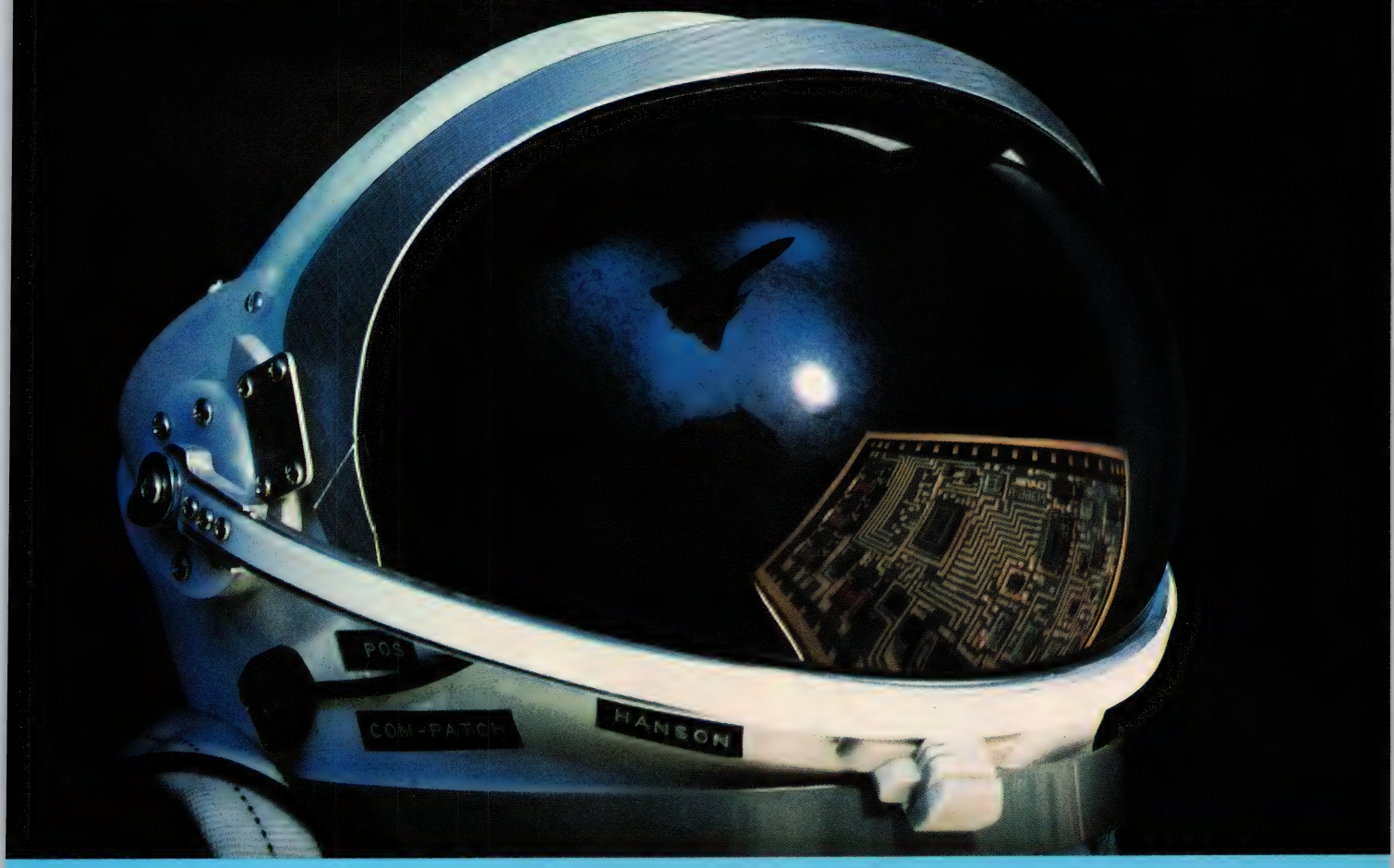
The 165 Singlemode Loss Set functions as an optical power meter and as a stable, 1300-nm light source, either separately or together. The instrument displays optical power and loss measurements over a +5 to −70-dBm range with ±0.5-dB accuracy. The light source's coupled, single-mode power specs at −25 dBm. The unit operates from an internal rechargeable battery or from 11 to 15V dc or ac lines. The unit measures 10×10¼×3¾ in. and weighs 8 lbs. $7150. Delivery, four to six weeks ARO.



Intelco Corp, 8 Craig Rd, Acton, MA 01720. Phone (617) 264-4485.

Circle No 393

You need speed plus precision to push the limits.



Datel's 500nSec 12-bit A/D converter.

It's high-speed performance plus true 12-bit precision. It's the new ADC-500 from Datel. And it gives you a combination of speed, accuracy, low power, and compact size that no other A/D converter can match.

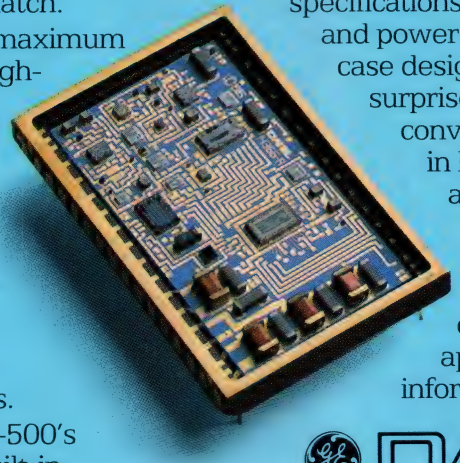
Very fast. The 500nSec maximum conversion time speeds throughput, boosts performance.

Very accurate. The ADC-500 offers *true* 12-bit precision. So you don't have to sacrifice performance for speed.

Very cool. Power is less than 1.7W for cool operation, with no need for heatsinks or restricted temperature ranges.

Very compact. The ADC-500's 32-pin hybrid package and built-in functionality save space and minimize the need for additional components.

What's more, the ADC-500 offers some special application-based features: a sample/hold trigger pin, complementary output pin, and an overflow pin that shows when signals are above or below full scale. And MIN/MAX specifications over operating temperature and power supply ranges give you a worst case design analysis—and help prevent surprises. With this innovative new converter, you can push design limits in both military and commercial applications.



Find out more about what our great new performer can do for you. Call (617) 339-9341, extension 241 to discuss your application and request additional information on the ADC-500.

DATEL

LEADERS IN DATA CONVERSION TECHNOLOGY
11 Cabot Boulevard, Mansfield, MA 02048
(617) 339-9341

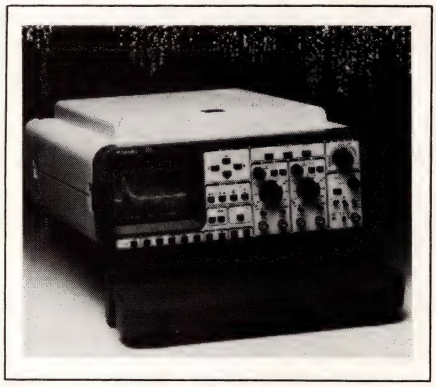
DISK EXERCISER

- *Writes patterns of zeros or ones*
- *You can seek any track manually*

The Model 1128 disk exerciser checks out 3½-, 5¼-, and 8-in. floppy-disk drives and 3½- and 5¼-in. hard-disk drives—providing the drives have standard interfaces. You manually select the track that you want the disk drive under test to seek. The unit can write a pattern of zeros or ones at the data rate appropriate to each type of drive. The exerciser provides test points for aligning drives. $625.

J & E Computer Service, 700 Alamo Dr, Morgan Hill, CA 95037. Phone (408) 778-0428.

Circle No 394



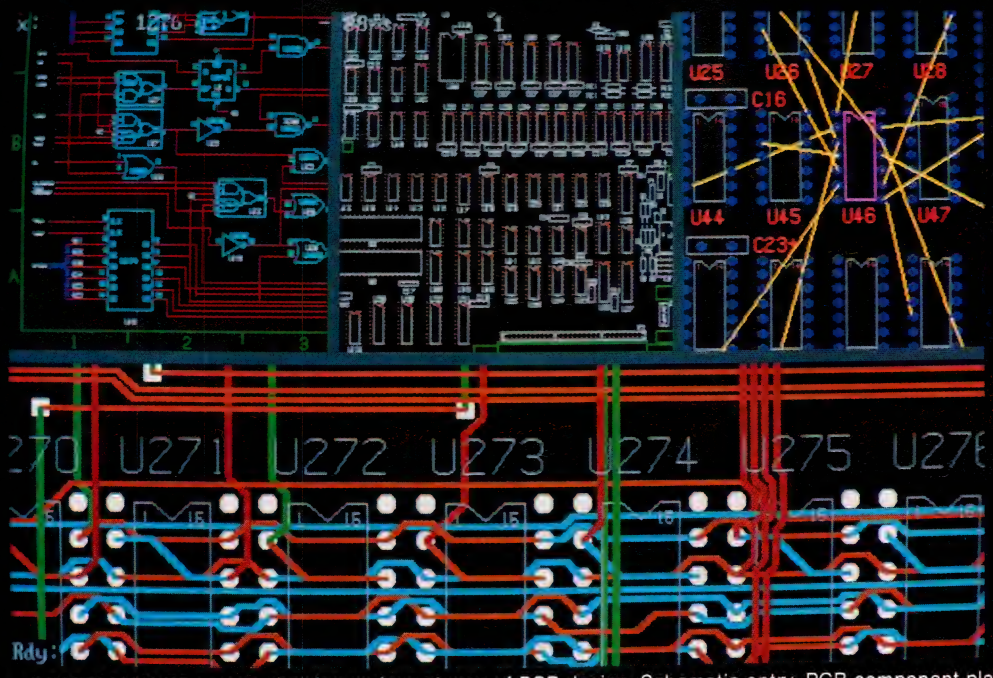
SIGNAL AVERAGER

- *Also functions as digital oscilloscope*
- *Can average analog signals or count pulses*

The NIC-370 signal averager simultaneously digitizes two channels at rates as high as 1M samples/sec with 10-digit resolution max. The instrument can average incoming signals continuously or function as a digital oscilloscope. You can use the two input channels for counting pulses at rates as high as 10 MHz. The unit can simultaneously display an averaged analog signal and a pulse count. It can also show frequency and interval histograms. The instrument comes with IEEE-488 and RS-232C interfaces. An optional bubble-memory cassette can store 21 captured traces. NIC-370, $9900; 321 bubble-memory option, $1900. Delivery, 120 days ARO.

Nicolet, Test Instruments Div, Box 4288, Madison, WI 53711. Phone (608) 273-5008.

Circle No 395



Pictured above is a DRAFTSMAN-EE screen showing various stages of PCB design. Schematic entry, PCB component placement, fine-tuning placement using rat's nest file, and editing the multilayer file. Design Computation brings professional CAE/CAD to PC-based workstations.

HIGH-END CAD SOFTWARE WITHOUT A HIGH-END PRICE TAG

Design Computation's sophisticated CAE/CAD design tools provide complete end-to-end solution for PCB design, at a value unmatched in the industry. IBM and AT&T compatible, all Design Computation products have a 30-day, unconditional money-back guarantee.

DRAFTSMAN-EE™

Design Computation's high-performance professional graphics editor for schematic capture and printed circuit design features unlimited zoom, orthogonal and diagonal rubberbanding modes, fast drawing speed, interactive autorouting and net list generation. DRAFTSMAN-EE™ can easily be configured with other Design Computation software for complete end-to-end solution for PCB design. DRAFTSMAN-EE™—powerful, flexible and fast—only $749.

DC/CHECK+™

Design Computation's manual routing tools provide accurate checking for precise PCB design. Ideal for analog designers and others who want total control of the routing process. Includes rat's nest creation, PCB-to-schematic netlist comparison, design rule checking and automatic generation of art masters for silk screens, solder masks and drill holes.

Increase your productivity and reduce errors with DC/CHECK+™ (requires DRAFTSMAN-EE™)—only $398.

DC/AUTOROUTER II™

Design Computation's professional autorouter offers high-end features and routing speed that put high-priced competition to shame. The field-proven DC/AUTOROUTER II™ is a true diagonal, 1-mil autorouter with typical completion rates of 93-99% and a cost-cutting route straightening and via minimization pass.

DC/AUTOROUTER II™ boasts expanded high-end power, permitting the use of memory boards adhering to the EMS standard. DC/AUTOROUTER II™ can handle over 500 IC's and boards as large as 32 x 32 inches. Medium sized boards with 70 IC's can be autorouted on a standard IBM PC/AT in under 2 hours.

DC/AUTOROUTER II™—the high-end autorouter you would expect to pay thousands more for—only $2,450. (Requires DRAFTSMAN-EE™ and DC/CHECK+™).

THE DESIGN COMPUTATION CHALLENGE

We encourage you to compare Design Computation's software against ANY CAE/CAD SOFTWARE AT ANY PRICE. We think you will be amazed.

Discover why Fortune 500 companies and engineering firms of all sizes are choosing Design Computation. Call or write today for your free color brochure, updated data sheets and **FREE Autorouter Demo.**

SYSTEMS FEATURES

- Manipulation of screen regions
- A through E size schematics
- X,Y flip and rotation at any angle
- Flexible scaling of text and symbols
- Netlist, Bill of Materials, and Parts List utilities included
- Keyboard recording and command procedures
- Component library included
- Multiple, user expandable text fonts
- Concurrent mouse and keyboard support
- Area fill for analog boards

- 1-Mil "gridless" operation and placement
- True diagonal autorouting - an absolute must for medium to high density boards
- Up to 16 trace layers
- Variable route widths
- Variable pad, via & drill hole sizes
- Common planes for power and ground
- Exclusion areas
- Interruptable and re-entrant
- Gerber photoplotters, pen plotters, printer output, Excellon Automation drill hole tape files

DESIGN COMPUTATION

Design Computation, Inc.
Ten Frederick Avenue, Neptune, NJ 07753
(201) 922-4111 TWX: 510-601-8352

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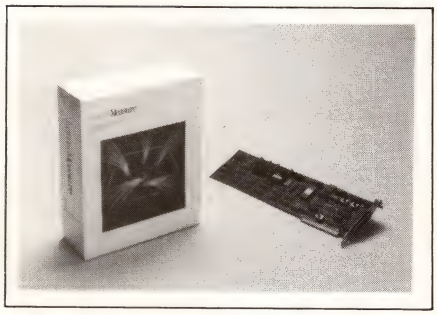
In **Holland & Belgium:** Klaasing Electronics 01620-81600, TELEX 54598, In **Greece:** Elcam Electronics, in **Athens**, TELEX 224282

NEW PRODUCTS

CAE & SOFTWARE DEVELOPMENT TOOLS



DATA ACQUISITION

- *Lets you acquire analog data for storage in 1-2-3 spreadsheet*
- *Analysis uses spreadsheet's math functions*

Measure is a software package for personal computers that lets you acquire data via the Metrabyte (Taunton, MA) DAS-16 and DAS-16F boards and store the values directly in the vendor's 1-2-3 spreadsheet. You can use the spreadsheet's math and graphics functions to reduce, analyze, and display the data. When installed, the program becomes part of 1-2-3; you can bring up the data-acquisition menus by pressing the Alt and F8 keys concurrently (these menus are similar in format to those of the spreadsheet). You can acquire as many as 64 channels of incoming data simultaneously at a maximum rate of 3000 samples/sec, and the program automatically converts the values to engineering units. You can display as many as 16 channels in real time. The program can also acquire data from more than 8000 different types of instruments via an RS-232C or IEEE-488 interface. Measure runs on the IBM PC, PC/XT, and PC/AT; the Hewlett-Packard Vectra PC; and the Compaq Portable. It requires 512k bytes of memory and runs with MS-DOS 2.0 or higher and Lotus 1-2-3 2.0 or higher. $495.

Lotus Development Corp, 55 Cambridge Parkway, Cambridge, MA 02142. Phone (617) 577-8500.

Circle No 396

FAILURE RATING

- *Computes failure probability from data on test samples*
- *Determines the most likely failure mode*

The Weibull Curve Fitter (WCF) is a reliability-analysis package that runs on an IBM PC or compatible equipped with at least 128k bytes of RAM. To determine the failure

probability of a component, you provide lifetime data on a sample of tested specimens. You may include nonfailed items in the sample. The program then fits the Weibull equation to the failure history of the sample and calculates the mean rank estimates of the cumulative probability of failure. The calculated results are the estimates of the characteristic lifetime, the Weibull slope, and the standard deviation of the fit. You can also request a nonzero minimum lifetime estimate. From the Weibull slope, you can determine whether the data indicates that the characteristic failure mode of the sample is random or is due to wear or very early failure. You may enter data from the keyboard or from disk files, and you can save edited data in a disk file for later analysis and plotting. The plot, which can include the fitted Weibull function, is alphanumeric, so you don't need any specialized graphics facilities in either the computer or the printer. The package includes Basic programs, which you can customize, and machine-language programs, which are optimized for speed. $39.95.

Dynacomp Inc, 1064 Gravel Rd, Webster, NY 14580. Phone (716) 671-6160.

Circle No 397

TOUCHSCREEN TOOLS

- *Provides interface between touchscreen and applications*
- *Graphics generator creates menus and help screens*

EZtouch is a memory-resident program for IBM PCs and compatibles that runs independently of applications software and is always available to read and control touch-input devices. It provides the software link between application programs and the vendor's touchscreen hardware devices. It also provides a means of creating menus for touchscreen systems and of programming touchscreen-system I/O tasks. Saywhat?! is a stand-alone graphics generator that lets you create screens with touch targets for use in application programs. You can create menus, data-entry and -display screens, and help screens. You can build boxes with or without border lines, fill them with color, and move them around the screen to create a visually balanced display. You can add text inside or outside the boxes, using either the standard or the extended character set of the PC. You can also direct the screen output to a printer. Both programs run under PC-DOS or generic MS-DOS. EZtouch, $149; Saywhat?!, $49.

Carroll Touch, Box 1309, Round Rock, TX 78680. Phone (512) 244-3500.

Circle No 398

CAE & SOFTWARE

3270 EMULATOR

- *Lets VME Bus systems communicate with IBM host*
- *Emulates 3274 controller on an SNA network*

The vSNA/3270 package is software for communications between VME Bus systems and an IBM mainframe. The package emulates the action of an IBM remote 3274 cluster controller on a System Network Architecture (SNA) network. Terminals and printers connected to the VME Bus host can exchange data with the IBM mainframe as if they were 3278 terminals and 3287 printers. By pressing a function key, you can also switch between VME Bus host applications and IBM mainframe applications. The package also lets you integrate data from the IBM mainframe with data from the VME Bus system. This first version of the package runs under Unix System V, BSD 4.2, or Xenix, on Systech Corp's (San Diego, CA) DCP-8820 VME Bus communications processor board; versions for other communications processor boards are in preparation. From $600.

Systems Strategies Inc, 225 W 34th St, New York, NY 10001. Phone (212) 279-8400. TLX 380226.

Circle No 399

SOURCE CODE

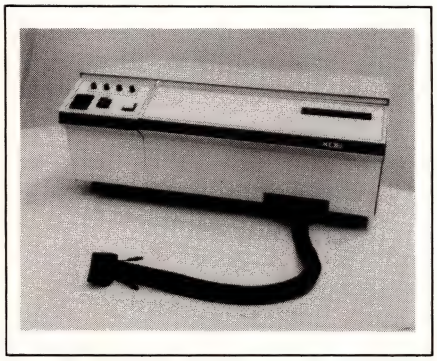
- *Lets you custom configure your MTBasic compiler*
- *Unnecessary functions are removable*

The source code for MTBasic, the Basic compiler that has become a de facto standard for complex process-control applications, is available for purchase. The compiler generates fast-executing code that is suitable for real-time, multitasking applications; it contains statements and functions that facilitate the manipulation of a wide variety of sensors and other process-control I/O devices. The compiler also provides

task-execution and -sequencing statements that let you run as many as 10 concurrent tasks. Availability of the source code lets you reduce the size of the compiler that fits into a ROM by, for example, removing the windowing functions. You can also add statements and functions of your own to handle application-specific I/O devices. Three versions are available: for Z80 systems; for 8088 systems; and for HD64180 systems. Each version, $5500.

Softaid Inc, 8930 Rte 108, Columbia, MD 21045. Phone (800) 433-8812; in MD, (301) 964-8455.

Circle No 400



DSP TOOLS

- *Software and hardware tools simplify DSP development*
- *MS-DOS and VAX/VMS versions are available*

An assembler/linker, a software simulator, and an emulator facilitate the development of digital-signal-processing (DSP) systems based on the TMS320C25 (a 100-nsec CMOS device that is pin- and software-compatible with the vendor's TMS32020 NMOS DSP, but has additional features and instructions). The assembler/linker lets you develop software for either of these two DSP devices. Two versions are available, one for TI or IBM personal computers and compatibles, the other for VAX/VMS computers; the price for each version is $500. The DSP-software simulator provides facilities for debugging and verifying programs off-line. Its main advantage is that it lets you associate files with I/O ports, so that you can repeat I/O values during testing and debugging. MS-DOS and VAX/VMS versions of the simulator are each $1500. The TMS320C25 emulator is a self-contained development system that has all the features necessary for full-speed in-circuit emulation; it has a 100-nsec instruction cycle. It lets you set real-time hardware breakpoints to monitor memory and register contents during execution. TMS320C25 development system, $13,500; upgrade kit for converting existing TMS32020 development system to TMS320C25 operation, $5500.

Texas Instruments Inc, Semiconductor Group (SC-665), Box 809066, Dallas, TX 75380. Phone (800) 232-3200, ext 700.

Circle No 401

CHROMATOGRAPHY

- *Acquires chromatographic data from instruments or in ASCII*
- *Uses menu-driven routines for data analysis*

Chromatochart-ASCII is a software package that runs on IBM PCs and compatibles that are equipped with at least 256k bytes of RAM, two 360k-byte floppy-disk drives, a color-graphics adapter (CGA) and color monitor, and an Epson-compatible printer. If your PC is also equipped with appropriate data-acquisition interfaces, the program lets you acquire data directly from gas chromatographs or hard-pressure liquid chromatographs. If you don't have data-acquisition hardware, you can still import chromatographic data files by using acquisition systems such as Labtech Notebook, Asyst, or the vendor's Adapt. Alternatively, the program lets you import chromatographic data from any source in ASCII format. The program uses menu-driven routines for data display and for peak detection, integration, and quantization. Its use of Savitsky-Golay smoothing techniques en-

sures peak detection, even for noisy data with a drifting baseline. The integration routines determine retention times, peak area, peak height, peak width at half-height, and skew. You can direct the program's graphic output to a dot-matrix printer or an H-P 7400 Series high-resolution plotter; you don't need an analog chart recorder. If you want to perform specialized analysis, you can store your results in files compatible with spreadsheets such as Lotus 1-2-3 or databases such as Database Manager. The program is not copy protected, and it can be installed on any hard disk. $595.

Interactive Microware Inc, Box 139, State College, PA 16804. Phone (814) 238-8294.

Circle No 402

DATABASE BUILDER

- *Simplifies the building of a database without programming*
- *Provides standard report formats you can modify*

Application Toolbox allows engineers and business people without any programming knowledge to design their own databases. The Toolbox, which comes with the NPL/R relational database manager, runs on the IBM PC/AT and compatibles. It consists of a menu-building module, a data-dictionary module, and a data-entry screen-painting module, which allow you to select a database and establish its format, and to create or update entries in the database. The package provides standard (default) sequences of operation and report formats that suit a wide variety of applications. You can, however, override the defaults and create your own control sequences and formats, if necessary, using keywords. The database manager can handle 10 data files and their indexes simultaneously and can sort keys that contain as many as 512 bytes. The package allows as many as 999 bytes per field, 255 fields per record, and record lengths as large as 10,000 bytes. $595.

Database Applications Inc, 400 Wall St, Princeton, NJ 08540. Phone (609) 924-2900.

Circle No 403

C INTERPRETER

- *Lets you use as many as 64k bytes of expanded memory*
- *Allows direct use of libraries from popular compilers*

Instant-C version 2.2 is a programmer's productivity tool that speeds the development of C language programs. It runs on IBM PCs and compatibles. The vendor has fixed a number of minor but annoying bugs that were present in earlier versions. The package consists of an interpreter that includes a source-code debugger, a full-screen editor, an incremental compiler, a linker/loader, a Lint-like syntax checker, a pretty printer, and a C function library. The interpreter executes the statements and expressions that you type and warns you of syntax or logic errors. You can use the editor to modify a specified function; it automatically calls the pretty printer to display the function in standard format. When you finish the editing task, returning to the interpreter automatically invokes the compiler and syntax checker. The new features include the ability to use, without change, object files and libraries created by Microsoft's V4.0 and some other C compilers. You can now use as much as 64k bytes of expanded memory (above the 640k-byte boundary but below the 1M-byte boundary). The ability to edit an entire memory file, using the new #edm command, makes it possible for you to rearrange your source files or do global searches without leaving Instant-C. Another added command lets you examine in a pop-up window the declarations of globals that are defined in files other than the one you are editing.

The vendor has also completely rewritten the installation appendix of the manual, as well as the chapters on the editor and on loading .OBJ files. Upgrade kits and site and network licenses are also available. Version 2.2, $495.

Rational Systems Inc, Box 480, Natick, MA 01760. Phone (617) 653-6194.

Circle No 404

PLOT-FILE DISPLAY

- *Displays Gerber-format plot files on an IBM PC's screen*
- *Handles 90 apertures with standard or custom codes*

CGerber displays Gerber-format plot files of pc-board designs on the screen of an IBM PC (or a compatible) that's equipped with at least 256k bytes of RAM and an IBM monochrome or color-graphics adapter. You can inspect the display for feature sizes, spacing, routing, and other design parameters, and you can detect errors before the file is sent to a service house for the production of an expensive mask. You can place a cross hair at one point and then another to measure actual target distances, feature sizes, and spacing, and see the result on a digital readout, in inches; for greater detail, you can display sequential sections of the image at any zoom factor from −200 to +100. A special feature lets you highlight all lines characterized by a specified D code (a code that characterizes the line for the plotter). Thus, if you lose the list of your D-code definitions (usually supplied separately on paper, not on disk), you can use the program to reconstruct the list. For trace and space inspection, the program can display lines of a drawing at their actual width (for a quick connectivity inspection, you can display them as 1-mil center lines). The program is compatible with most Gerber (RS-274) plotting formats. It can handle as many as 90 apertures with either standard or custom tool and D codes, and it handles feature sizes from 1.0 to 999.0 mils in 1-mil steps. $450.

Consultek Inc, 430 Quartz St, Redwood City, CA 94062. Phone (415) 368-8788.

Circle No 405

EXPERT-SYSTEM TOOL

- *Offers prepackaged user and program interface modules*
- *Provides three types of inference mechanisms*

Knowledge Engineering System II (KES II) simplifies the development of expert systems by offering prepackaged components that you can use individually or in combination. The components include user and

program interfaces, and three different inference mechanisms: KES II HT, which is based on a hypothesize-and-test approach to problem solving; KES II PS, which is based on production rules that test whether a situation meets certain criteria; and KES II Bayes, which uses Bayesian probability and historical information to predict the outcome of an action. KES II PS is currently available for the vendor's family of MS-DOS personal computers and Unix-based Series 5000 computers. All KES II modules will become available for these and other computers early this year. KES II PS for PCs, from $500; for Series 5000 machines, from $1000.

Unisys Corp, Box 500, Blue Bell, PA 19424. Phone (215) 542-4526.

Circle No 406

TEXT EDITOR

- *Split screen allows transfer of material between files*
- *Automatic indenting for structure-language source code*

Mix Editor runs on the IBM PC and compatibles and incorporates features that facilitate the preparation of source code in a high-level language. You can split the screen horizontally or vertically and display part of a different file in each half; you can then move blocks from one file to the other. The editor provides automatic indentation for source code in structured languages such as C or Pascal. It provides automatic line numbering for Basic. For English text, you can fill each line to a preselected width, and you can select ragged-right or justified text. The program offers more than 100 commands; you can define your own macros from these commands. $29.95.

Mix Software Inc, 2116 E Arapaho, Suite 363, Richardson, TX 75081. Phone (214) 783-6001.

Circle No 407

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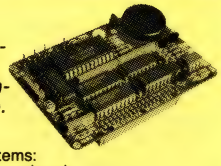

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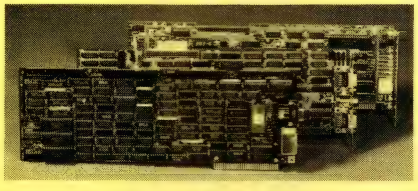

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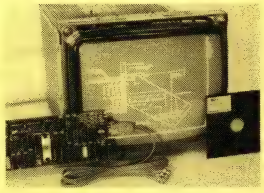

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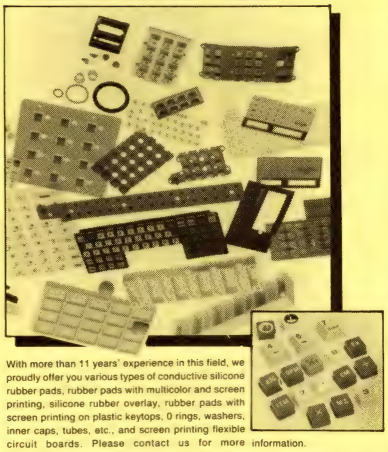

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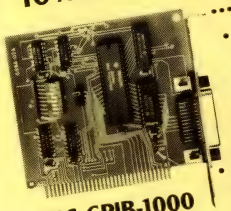

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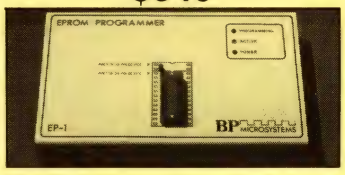

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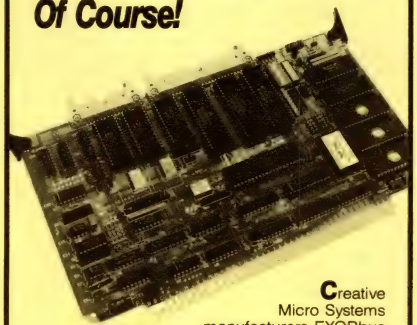

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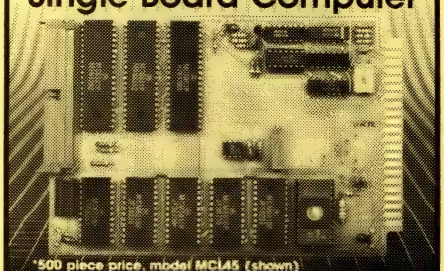

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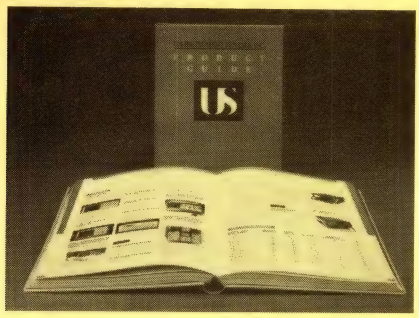

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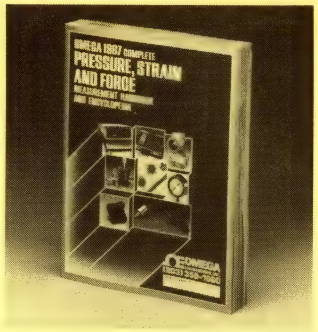

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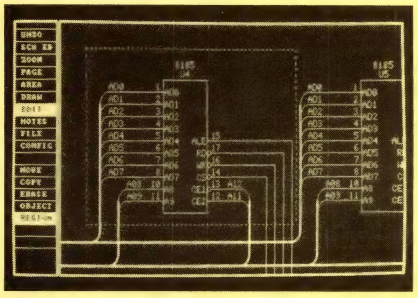

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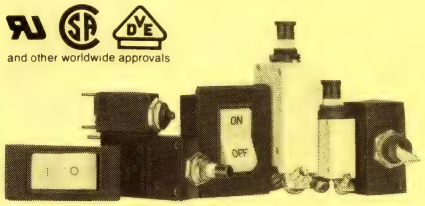

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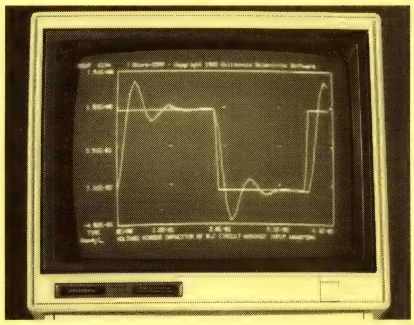

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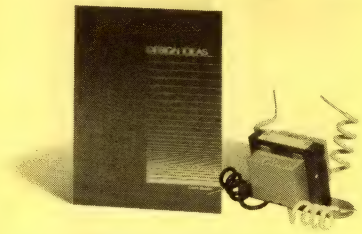

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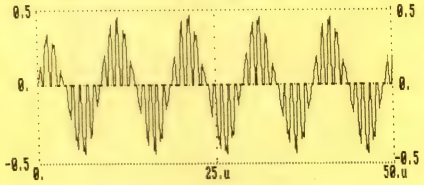

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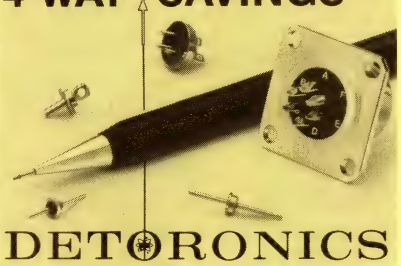

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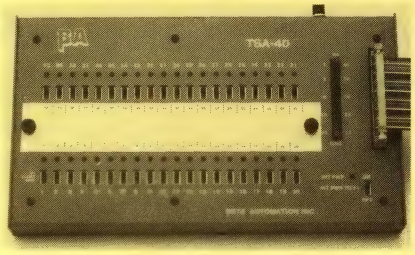

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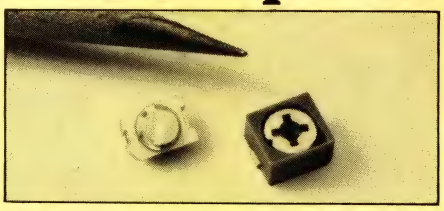

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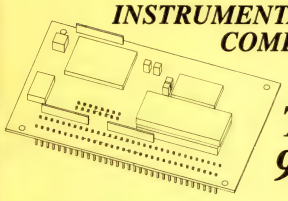

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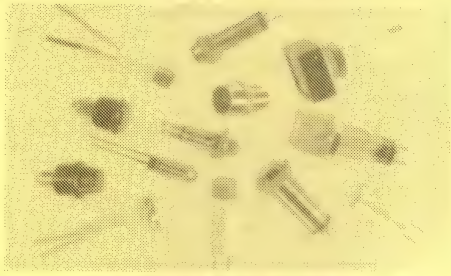

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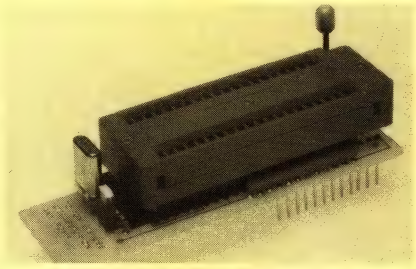

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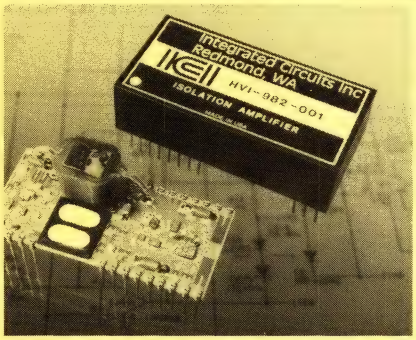

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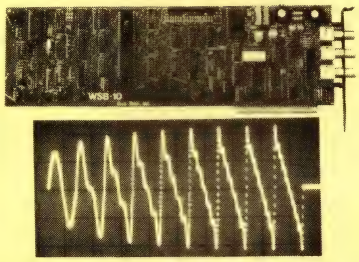

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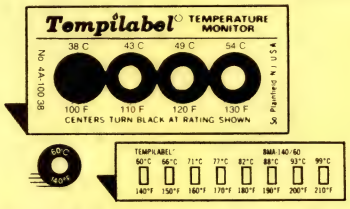

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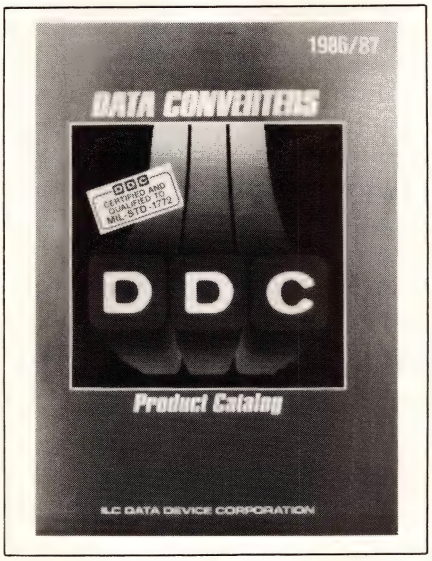
LITERATURE



Compendium of data-bus products

This 463-pg catalog covers the vendor's entire line of data-conversion and data-bus products, including A/D and D/A converters; synchro-to-digital and digital-to-synchro converters; S/H and T/H amplifiers; synchro and Selsyn instruments; and MIL-STD-1553 components. Further, the catalog highlights units providing special functions—for example, control transformers, a synchro booster amplifier, and Inductosyn-to-digital converters. Photographs, block diagrams, and plots of performance curves are included. Application notes and a listing of flat packs completes the catalog.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 408

App note examines trimming of monolithic chip

Wafer Level Trim of Monolithic Digital-to-Analog Converters, a 4-pg application note, considers the factors to remember when you're trimming a chip that contains most of the active components of a D/A converter. The document presents a detailed analysis of various types of trimming (Vapox, laser, mechanical, and resistor) and describes the mounting of wafers in fixtures as well as the required software organization. In conclusion, the note concedes that, although wafer-level active trimming of monolithic devices is a complex process, it's not too difficult to maintain high device yields once you understand the various contributing factors.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 409

Catalog covers line of electromechanical products

This 22-pg catalog details the mechanical and performance specifications of the company's new line of Quiet Force fans and blowers. Products highlighted include ac and brushless-dc tubeaxial fans and forward-curved centrifugal blowers as well as accessories. The catalog illustrates key aerodynamic and acoustic properties and provides air-mover descriptions. It also contains a page of technical definitions, and it's punched for filing.

Howard Industries, 1 N Dixie Hwy, Milford, IL 60953.

Circle No 410

Publication indexes product inventory

The 36-pg *Metric Mart,* a bimonthly sales publication, describes equipment that this company previously rented and is now offering for sale. This edition's representative products include general-purpose, industrial, and telecommunications test equipment; microprocessor development systems; and desktop computers and controllers. Representative manufacturers include Hewlett-

Packard, Tektronix, Fluke, and Hekimian. The vendor tests, calibrates, and inspects all equipment before delivery. The company also guarantees that each product will meet the original manufacturer's specifications, and it provides a 90-day warranty.

Metric Resources Co, 9246 Gaither Rd, Gaithersburg, MD 20877.

Circle No 411

Brochure highlights family of modem ICs

This 8-pg brochure features the K Series, a family of pin-compatible, single-chip modem ICs. The 2-color booklet describes the characteristics of the four circuits and presents tables, charts, and graphs of supplemental data. One chart depicts a comprehensive software-register scheme for the family. Device pinouts are included. The brochure also lists relevant design-application literature available.

Silicon Systems, 14351 Myford Rd, Tustin, CA 92680.

Circle No 412

Two books reference power MOSFETs

These two data books offer information on the manufacturer's power products and COOLFET MOSFETs, respectively. The 250-pg power-products compendium includes data sheets on power MOSFETs, ultrafast-recovery rectifiers, and MOSFET and rectifier dice. It also covers applications data for power supplies and motor controls, and it includes a selection guide and a cross-reference. The 96-pg COOLFET booklet contains selection guides and spec sheets for each of the 16 n-channel power MOSFETs.

Fairchild Semiconductor Corp, c/o Analog Div, 313 Fairchild Dr, Mountain View, CA 94039.

Circle No 413

BOOK REVIEW

Rigid Disk Drive Heads and Media: A Technology and Marketing Report, *approximately 150 pgs; $795 ($75 for additional copies); TAGi Publications, Saratoga, CA, 1986.*

The electronics industry harbors several disciplines that many engineers consider black art because of scarce published information. Rigid-disk-drive design and technology is certainly one of those disciplines. *Rigid Disk Drive Heads and Media* starts to fill the gaps in our knowledge of this field. It delivers a wide range of information covering the history of rigid-disk-drive development, head and media technology, and market forecasts.

Chapter 1 chronicles rigid-disk-drive development from 1957 to the present day. Development of drives occurred during three epochs, classified as the classical period (1957 to 1974), the Winchester period (1973 to the present), and the thin-film period (1979 to the present). IBM plays the major innovative role in this chapter, and the book lists technology firsts, relating them to specific drive products and first-customer-shipment (FCS) dates. Over these three epochs, technology improvements to heads and media increased the area bit-storage densities achieved in rigid-disk drives by four orders of magnitude, from 2.1k bits/in^2 for the 350/1, IBM's first commercial disk drive, to today's densities of 30M to 50M bits/in^2.

The second chapter looks at the five head and four media technologies currently used in commercially available disk drives, and it discusses the characteristics of selected drives that use various combinations of heads and media. Chapter 3 explores media technology in depth, including discussions of specific media products available from vendors. This chapter also includes a table that lists 45 media vendors (both merchant and captive), indicates what types and sizes of media each vendor manufactures, and shows what percentage of the market each media technology represents. Chapter 4 similarly covers heads, and one of its tables lists 32 head-manufacturing companies.

A 16-page glossary defines terms specific to the disk-head and -media industry, and it's followed by the book's four appendices. Two of the appendices contain company profiles of the head and media vendors listed in earlier chapters. The remaining two appendices forecast the market requirements for media and heads, respectively, through 1988. The book has an index.

—Steven H Leibson

NEWS

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MARCH 1987

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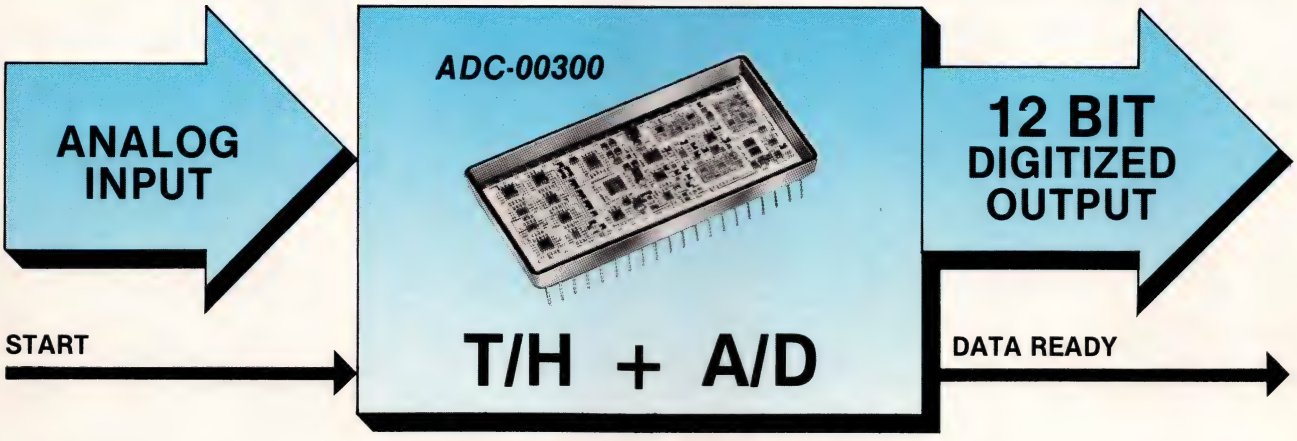

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With its output registers and tri-state buffers, the ADC-00300 interface to most CPUs is a simple task. It provides 9 bipolar and unipolar jumper-selectable analog input ranges. Since all timing is self-contained, the ADC-00300 requires only an encode command input to start its conversion cycle.

The ADC-00300 has been characterized for use in signal processing applications. Its signal-to-noise ratio and harmonics are specified respectively at 65db minimum and 68db minimum.

A number of factors contributed to achieving the ADC-00300's technical breakthrough in speed and size. Foremost among them were the high speed DAC and the amplifier which follows it. Both are DDC proprietary designs, and moreover the DAC is a single custom IC. In addition, judicious use of thin film and thick film hybrid technology resulted in minimum layout area. Thin film, with its fine lines, was used in the track/hold and other analog sections to minimize stray capacitance and crosstalk. Thick film, with its multi-layer capability, was used in the digital sections to minimize layout area.

The ADC-00300 is implemented with a 2-step A/D conversion algorithm, which operates as follows: First, the track/hold samples and stores the analog input signal, after receiving an external start command. Then, a flash ADC generates a coarse encode of the sampled voltage and stores its 7 bits in the MSB register. At the same time, a high speed DAC and amplifier convert the 7 bits to an analog voltage, which is subtracted from the original input. Next, the flash ADC generates a fine encode of the subtracted voltage and stores these 7 bits in the LSB register. Finally, the contents of the 7 bit MSB and LSB registers are combined in a digital error correction circuit to yield the 12 bit output. All of these steps take place in a total of 500 nanoseconds.

Its high speed, wide operating temperature and small size, make the ADC-00300 ideal for numerous digitizing requirements such as radar and sonar digitizing, electronic warfare receivers, digital signal processors, medical and nuclear instrumentation and high speed data acquisition. Learn more about the new ADC-00300 by contacting the nearest DDC office. □

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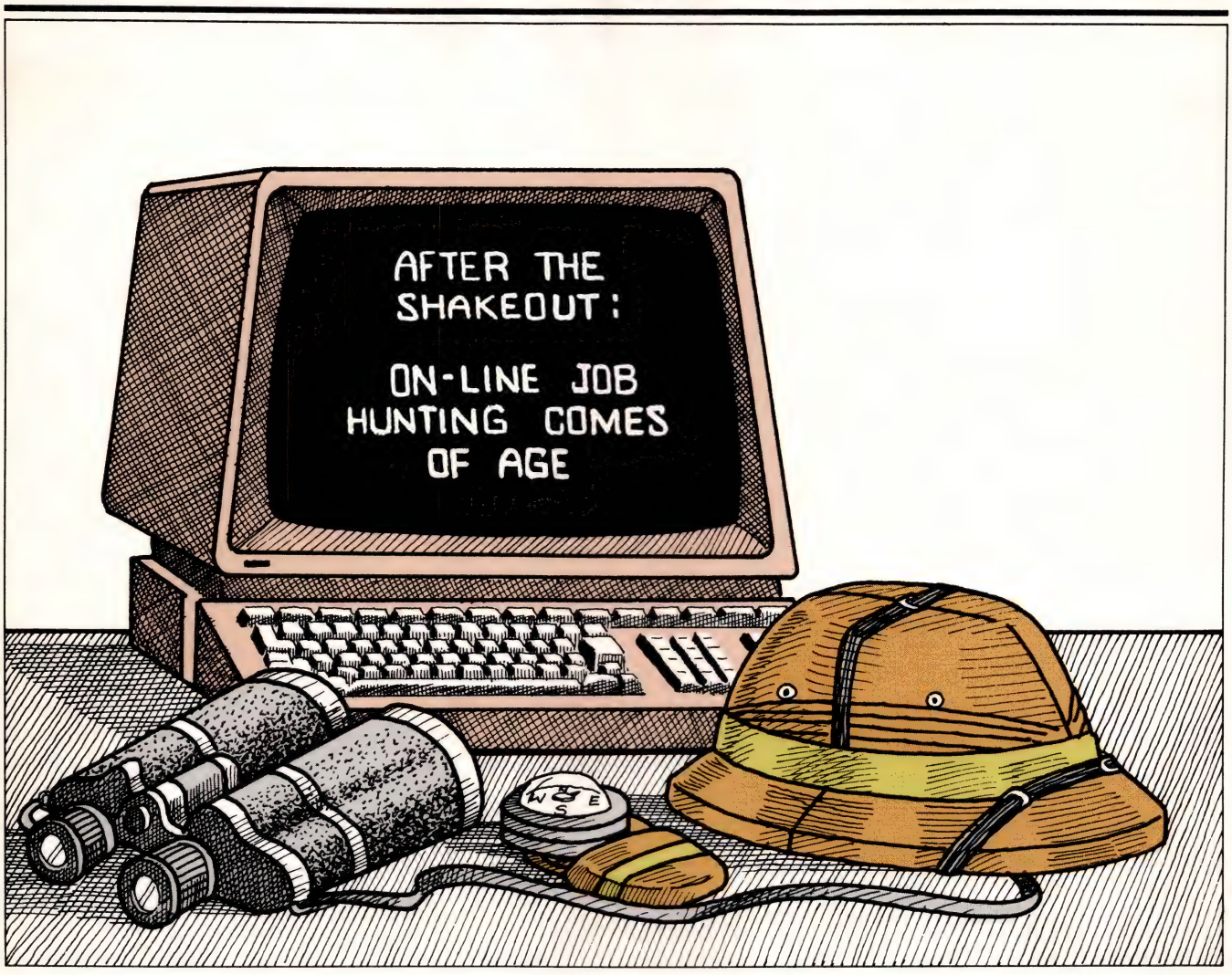
PROFESSIONAL ISSUES



Raymond Medici

Deborah Asbrand,
Associate Editor

It seemed like a good idea at the time. Engineers from all over the country could file their résumés in a database, and corporate recruiters would access the system to find candidates for technical job openings. The database would operate on the teleprocessing network of industry giant General Electric. Résumés would be kept confidential; the system was programmed so that employers who accessed it would not be furnished with the names of employees from their own company.

Within several months of its much ballyhooed sendoff, however, the database shut down. There is no longer a telephone listing for the Schaumburg, IL, company that maintained the database, and a General Electric spokesman isn't even sure what happened to the venture. The company apparently "just couldn't make a go of it," he says.

Many other on-line résumé databases and advertising services opened for business in 1983 and 1984. They were touted as the latest in recruitment technology. Yet most were poorly conceived and unable to fill the needs of either corporate recruiters or job seekers. By 1986, most of the databases had gone out of business. A few on-line services still survive, however, and that translates to good news for job hunters: The surviving services are the more efficient ones, and because there are fewer of them, each has a larger pool of prospective employers to offer job seekers.

The early résumé databases suffered from a number of problems. First, rather than solicit résumés from individuals interested in changing jobs, some companies purchased mailing lists from professional associations, placed the names and professional data on file in a computer, and made the lists of names available to recruiters. Recruiters quickly discovered that their telephone calls to individuals listed in the databases were often unwelcome.

Winter, Wyman & Company, a Waltham, MA, recruiting agency that specializes in placing technical professionals, considered automating its recruitment process in the early 1980s and contemplated using one of the database services available at the time. "We evaluated one system and made calls to several people," says Jerry Marstall, vice president and general manager of

Winter, Wyman & Co's research and development division. "The people were not receptive because they had already been contacted by several recruiters." In addition, Marstall recalls, some individuals were upset to discover that their names had been placed in such a file without their consent.

Recruiters, whether working in house for a corporation or working for a placement agency, also complained that on-line databases left them no way to accurately assess the skills, talents, and personalities of the candidates on file. Traditionally, the granting of a large proportion of job interviews is based on a recommendation from another employee or recruiter. With no personal endorsements of the candidates available, recruiters said the lists proved to be of little help to them. Bob Smith, president of Johnson, Smith, and Knisely, a New York executive search firm, says flatly, "If it's not a screened list of individuals, I'm not interested in it."

Some database firms simply tried to serve too many industries. Some databases included names and résumés of professionals from a variety of fields, combining engineers and scientists with schoolteachers and health-care workers. Most found that, ultimately, they were unable to serve any of those markets adequately. Still other database services sought to maintain banks of individuals' names from all across the country, ignoring the fact that many recruiters—and job hunters, as well—are interested only in local or regional listings.

Limiting a database's participants to technical professionals made sense: It paired a new use for computer and communications technology with the individuals who would be most comfortable using it.

Updating the supply of names

Yet even with these misjudgments, more of the companies might have survived had they been able to keep a fresh supply of names flowing into their databases. Recruiters quickly lost interest in the services when they continued to see the same names each time they accessed the files. "It's very expensive to replenish a database and keep it current," says Jill Nagel, product manager for BPI Adline, an on-line recruitment advertising service that opened last year in Minneapolis, MN. "If companies don't see fresh names coming through every day, they're not going to be satisfied and stay on."

"If you look at the companies that went under, you'll see that they didn't provide sufficient [client] satisfaction," says Clark Willmott, president of Telejob (Lexington,

Your next interview may be on film

Gordon Dolph calls himself "a student of the job-interview process." During his 20 years of work in industrial relations and recruitment, Dolph found that job interviews were generally conducted in an inefficient manner. Personnel administrators often conducted preliminary interviews, information changed hands several times, and the hiring manager rarely became involved until late in the process.

When new technology produced affordable videotape of good quality, Dolph saw an opportunity to improve the flaws in the traditional hiring process. He believed candidates and companies both would benefit from videotaped interviews that were conducted by an independent source. Dolph teamed up with a partner and spent two years conducting market research on the idea of videotaping job interviews.

The result is the Corporate Interviewing Network (CIN), a Fort Lauderdale, FL-based company, of which Dolph is now the executive vice president. CIN estimates that its 26 franchises conducted more than 3000 videotaped interviews last year. The bulk of the company's 500 corporate clients are in the health-care, high-technology, financial, and manufacturing sectors. Its clients include Allied-Bendix Aerospace, General Motors Technical Center, Honeywell, and Westinghouse Electric's Industry Services Division.

Dolph says that for hiring employers, the advantage of videotaped initial interviews is that they can view the tapes in a more timely and efficient manner. For example, company representatives, after working with CIN's staff to develop interview questions, can view the videotaped interviews when their schedule permits.

A CIN staff member conducts the interview in a local CIN office. Few job candidates seem bothered by the camera's presence, says Dolph. "Candidates say they feel the process is fairer because the interviewer is impartial," says Dolph. "They like the fact that their interviews go directly to the decision makers." Dolph emphasizes that CIN's service is designed for use only during initial, screening interviews.

MA). "The employers didn't get enough résumés on their desks." Willmott is well-acquainted with the perils of on-line résumé databases. His company operated such a service for two and a half years before deciding to end the effort.

From 1982 to early 1985, Telejob offered computerized recruitment advertising. Job hunters who telephoned the company's banks of operators were asked questions about their professional backgrounds and interests. The company then fed that information into a computer, which matched the individuals with any appropriate job openings that Telejob had on file. Callers who were interested in any of the positions were sent more information. Individuals still interested after reading the information could send their résumé to the company.

Telejob had 250 client companies and posted more than 1200 job listings during its 2½-year existence. Willmott says that the company's clients included Digital Equipment Corp, Raytheon, and Wang Laboratories. He estimates that 300 to 350 individuals found new jobs through the service.

Despite some success, however, the operation wasn't profitable. "Our problem was that in order to build a big enough database, we had to spend enormous amounts of money on advertising," Willmott says. And with the service not yet earning a profit, he decided against plowing any more money into it and abandoned the operation in 1985.

An IEEE-assisted service

One on-line résumé database that survived the fray is the Professional Engineering Employment Registry (PEER), a service initiated by the IEEE in 1983. In addition to the IEEE, the PEER résumé database serves the 750,000 members of 29 other technical societies. Fifteen thousand new résumés enter the database every 60 days, according to Joe Stacey, president of Career Technologies, the company responsible for administrating and maintaining the database. The database's 300 clients—which include such diverse employers as Allied-Bendix, Digital Equipment Corp, Raytheon, and the US Navy and the Department of State—access the system through terminals installed at their own facilities.

Raymond Medici

"In the past year, the service has come of age," says Charles Stott, chairman of the IEEE Employment Assistance Committee. "It now has enough participants on both sides—employees and employers—to be useful." The IEEE has been so pleased with the database's performance that it plans to begin a second database of full- or part-time independent consultants.

Stacey credits the technical focus of Career Technologies' database as one reason for its success. While some databases stored résumés for a diverse group of professionals, Career Technologies chose to limit its listing to engineers, scientists, and computer specialists. "In the early days, we had only 10,000 résumés," says Stacey. "Other services had more, but they covered the spectrum from schoolteachers to blue-collar workers. Our effort was always focused."

Seal of approval helps

Also key to Career Technologies' success is its database's endorsement by the technical societies. With 30 societies promoting the service, the database has tapped vast reserves of free publicity that other services lacked. In addition, the link with the technical societies boosts the system's reputation. "The societies' participation enhances our credibility significantly," Stacey notes.

Another factor in the company's success is the interest it took in tailoring its database to the technical professionals who would use it. For example, unlike other databases that required job hunters to present their résumé information in a specific format, Career Technologies accepts individuals' actual résumés into their files. "Engineers don't like to code themselves into an application form," explains Stacey. "They take pride in the way they represent themselves."

A perfect match

The decision to limit its database to technical professionals was not only a potentially lucrative one for Career Technologies, but a sensible one as well: It paired a new use for computer and communications technology with engineers, scientists, and computer professionals—individuals who would be most comfortable using it. A similarly well-planned venture might not succeed in industries where workers aren't as familiar with computers and databases. Stacey cites the health-care industry as one example of a business sector that's growing fast but is still too populated with individuals unaccustomed to computers to be ready for computerized job search.

The erratic past of résumé databases has limited the number of newcomers to the field. One new

entrant, however, appears to be carefully avoiding its predecessors' mistakes. Instead of assembling a database of names, Business People Inc (BPI) of Minneapolis, MN, has chosen to organize a computerized classified advertising service. Called BPI Adline, the business opened in early 1986.

Designed for technical professionals, BPI Adline job advertisements are accessible by modem. It currently posts openings in engineering, computer science, and finance for 10 companies, which include Emerson Electric, GTE, LTV, Rohr, and Unisys. Jill Nagel says that the companies report an average of 650 inquiries each month, with 200 to 300 résumés being logged on.

More of the résumé-database companies might have survived had they been able to keep a fresh supply of names flowing into their databases.

To promote its service, BPI Adline has undertaken a $2.5 million advertising campaign in newspapers and trade journals. Nagel points out that the service receives additional publicity through its clients' own recruitment ads, many of which include Adline's telephone number as a source of further information. BPI hopes the blitz of publicity will ensure a continuous flow of new users to the system.

Sharing Adline's niche, however, is Career Technologies, which has operated an on-line recruitment advertising service as part of PEER for the past three years. The service lists technical openings in 50 corporations, including Digital Equipment Corp, Honeywell, and United Technologies. Stacey reports that each company advertises anywhere from two dozen to 200 job openings via the service. Job seekers without modems can also access Career Technologies' listings. Using a pushbutton telephone, callers can interact with the voice-synthesized system to obtain information on listings and an address to which they can send their résumés.

Taking a closer look at the services

Computer users access PEER by dialing (617) 275-4112 and entering the password "PEER". The caller may then choose, from a menu, to review the basics of how the system works, or to partake directly of the available services. The system gives the address to which the caller sends a résumé, which is kept in a database that prospective employers can consult; Career Technologies will notify the caller when a company expresses interest. Alternatively, the system user may read through a list of job openings or review text presentations from specific companies.

On the day EDN contacted PEER, the database contained more than 170 job openings in 11 technical categories. Engineering job openings were listed under the categories of electrical/electronics, hardware, software, optical, mechanical, civil, and nuclear. Each job listing was followed by an identification number that viewers use to specify the jobs in which they're interested.

Eight companies, including Computervision, Norden Systems, Digital Equipment Corp, and Pratt and Whitney, gave presentations. Each presentation covered the company's job openings, employee benefits, and, usually, the community in which the facility was located. At the conclusion of each presentation, the company furnished the name, the address, and in some cases the telephone number of a personnel representative to whom résumés could be mailed.

Job hunters without a computer can also use PEER. By dialing (617) 275-4462 on a pushbutton telephone, pushing the user-response number "200#,225#", and entering the password "7337#", callers reach PEER's talking computer. The service is not accessible via a rotary telephone.

Getting into BPI Adline

You can reach BPI Adline by dialing (612) 941-5723 and entering the password "BPI". The service had openings from seven companies on the day we accessed it. Companies using the service included Emerson Electric, GTE Government Systems, Northrop's Advanced Systems Division, and Sperry's System Integration Division. The companies showed a variety of openings for ATE engineers, software systems engineers, and project supervisors, to name a few. Each listing specified job responsibilities, preferred experience, and desired educational background.

The system invites users to upload their résumés to the file after they've viewed the menu's contents, and it advises users to check the system every 30 days for updated listings. BPI also uses the system to promote its other business, which is technical job fairs. BPI sponsors 40 job fairs each year and notifies users of the Adline system when there is a job fair occurring locally.

ISSUES

Though the two services share the same niche, there's one important difference in the ways they operate. Callers to BPI Adline upload their résumés directly to the company's files; PEER users send in their résumés to Career Technologies by mail, and staff members enter the résumés into the database.

Reaping the greatest benefits from the heightened competition will be job hunters, as the remaining databases improve their services to win over more users. Willmott, however, predicts that the most practical databases are probably yet to come. The real boon for job hunters, he forecasts, will occur when large regional newspapers begin to put their help-wanted advertisements on line. **EDN**

Article Interest Quotient
(Circle One)
High 518 Medium 519 Low 520

CAREER OPPORTUNITIES

1987 Editorial Calendar and Planning Guide

EDN

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
Apr. 30	Apr. 9	Communications Special Issue; ASICs; Test & Measurement	Closing: Apr. 2 Mailing: Apr. 23
May 14	Apr. 23	Analog Technology Special Issue; ICs; Test & Measurement	
May 28	May 7	Computer Peripherals; Software; Power Sources/Devices	Closing: Apr. 30 Mailing: May 21
June 11	May 21	Math ICs; CAE; Computers	
June 25	June 4	ASIC (Semicustom ICs) Directory; Analog ICs; Surface-Mount Technology	Closing: May 28 Mailing: June 18
July 9	June 18	Product Showcase-Volume 1; ICs & Semiconductors; Software	
July 23	July 2	Product Showcase-Volume II; Computers & Peripherals; Test & Measurement Instruments	Closing: June 25 Mailing: July 16
Aug. 6	July 16	Computer Boards; Digital Signal Processing; Test & Measurement; Top Ten Reader Vote Contest	
Aug. 20	July 30	Military Electronics Special Issue; Fiberoptics; Software	Closing: July 23 Mailing: Aug. 13
Sept. 3	Aug. 13	Analog ICs; CAE; ASICs	
Sept. 17	Aug. 27	Memory Technology; Communications Technology; Software	Closing: Aug. 20 Mailing: Sept. 3

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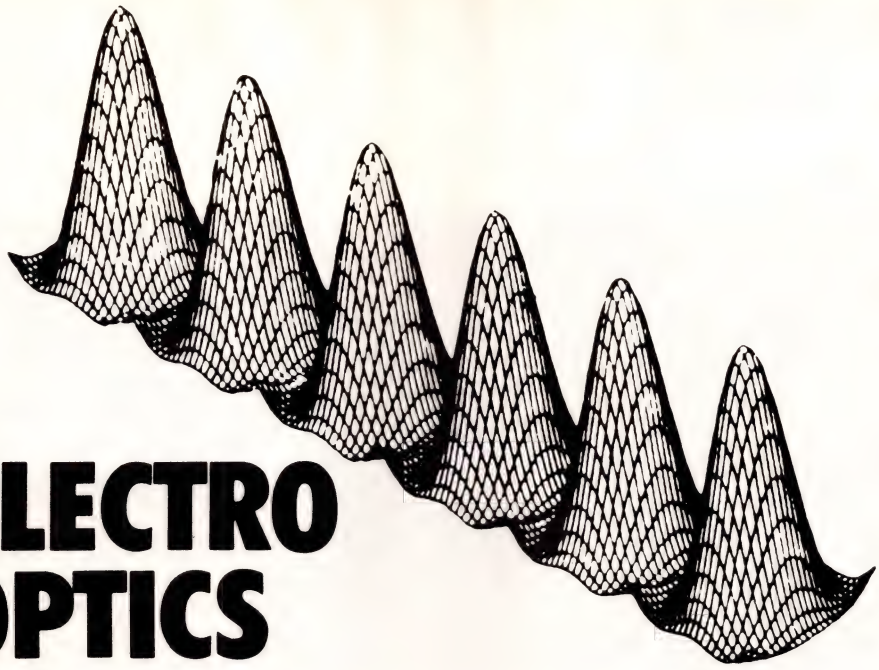

ELECTRO OPTICS

Major research efforts at Lincoln Laboratory involve the development of electro-optical systems for laboratory and field experiments. These systems utilize state-of-the-art lasers, computers, sensors and electronics. Applications include high-power laser beam control, and target detection and discrimination for the national defense.

ADAPTIVE OPTICS

Atmospheric compensation and laser-device-quality improvement are major tasks in a growing Laboratory program. Applicable technologies include wavefront sensing, servo-control systems, optics and laser sytems. Novel techniques using non-linear optics are also under active development.

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Using focal plane arrays and unique telescope design, systems using both airborne and land-based sensors are being designed for detection and classification of targets.

ADVANCED TELESCOPES

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LASER RADAR

Multi-dimensional laser radar systems are being developed in order to classify, discriminate, and track both tactical and strategic targets. Image processing, binary grating optics, and high speed data procesing are utilized in these laser radar systems.

We are expanding our research activities and need individuals with experience in quantum optics, atmospheric physics, image and signal processing, adaptive optics, servo systems, optical engineering, circuit design, mechanical engineering and signal processing. A PhD or MS in Physics/EE/ME is required.

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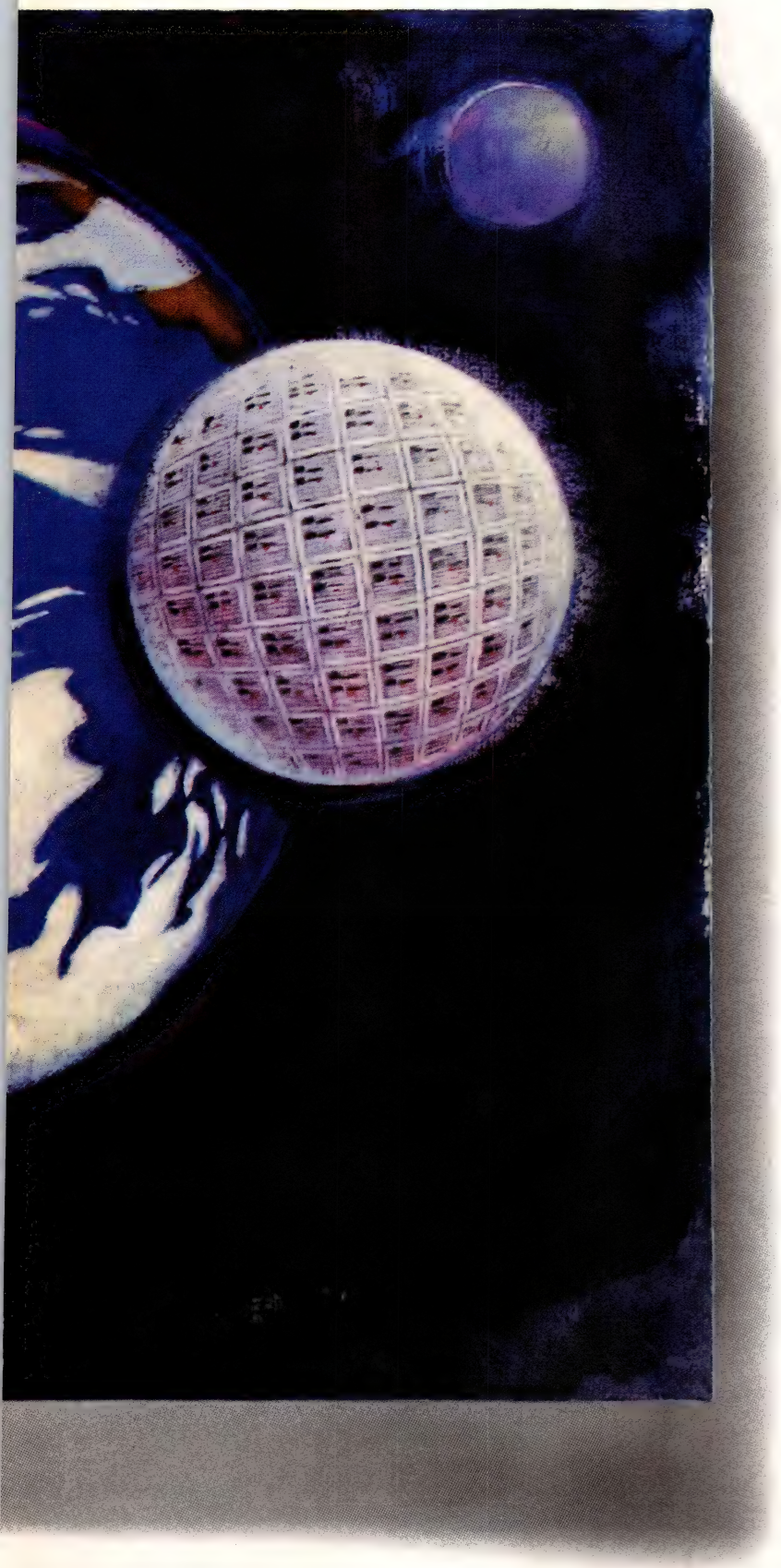

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Honeywell in Phoenix

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Lead the design and development of software for distributed systems, data communications and data base management systems. You should have experience in ADA, MIL-STD 2167, tools and methods and ISO/OSI protocols. Ten or more year's aerospace experience is required.

Electronics Engineers

Openings include analog circuit design for signal processing, electromechanical components and digital circuit design applicable to signal multiplexer/demultiplexers. You should be familiar with microprocessor-based designs, serial digital I/O, A/D conversion techniques and power supply design.

Systems Software Engineers

In these positions, you will generate systems software specifications from systems requirements, develop software requirement documents, computer algorithms, flow diagrams, software test requirements and verification/validation plans. You should have experience with Assembly and higher-order languages.

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These positions are involved with the design of hardware for space applications. You will work with extreme vibration, shock and thermal environments coupled with stringent weight and reliability requirements, and use exotic materials and accurate mechanical designs. Analytical requirements vary from fundamental thermal, structural and vibration analysis to detailed analysis techniques. Electronics packaging and robotic mechanisms are also required for our emerging product lines. To qualify for these openings, you should have a BS degree in Mechanical Engineering and a minimum of three year's experience.

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Test Systems Engineers

Positions open include test system design, test hardware development, test software development and system simulation. To qualify for software and systems positions, you should be familiar with HP-1000 and HP-9800 series hardware and software or with the MC68000 microprocessor, Unix operating system, "C" and ATLAS languages. Test hardware development will require a background in analog or digital circuit design.

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In these positions, you will perform senior-level digital hardware design on high-volume, high-reliability products. You should be familiar with MIL Specs and have prior experience on military production programs.

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This position requires experience in fiber optics communications components and a working knowledge of sources, detectors and interface electronics including modulators and signal processors.

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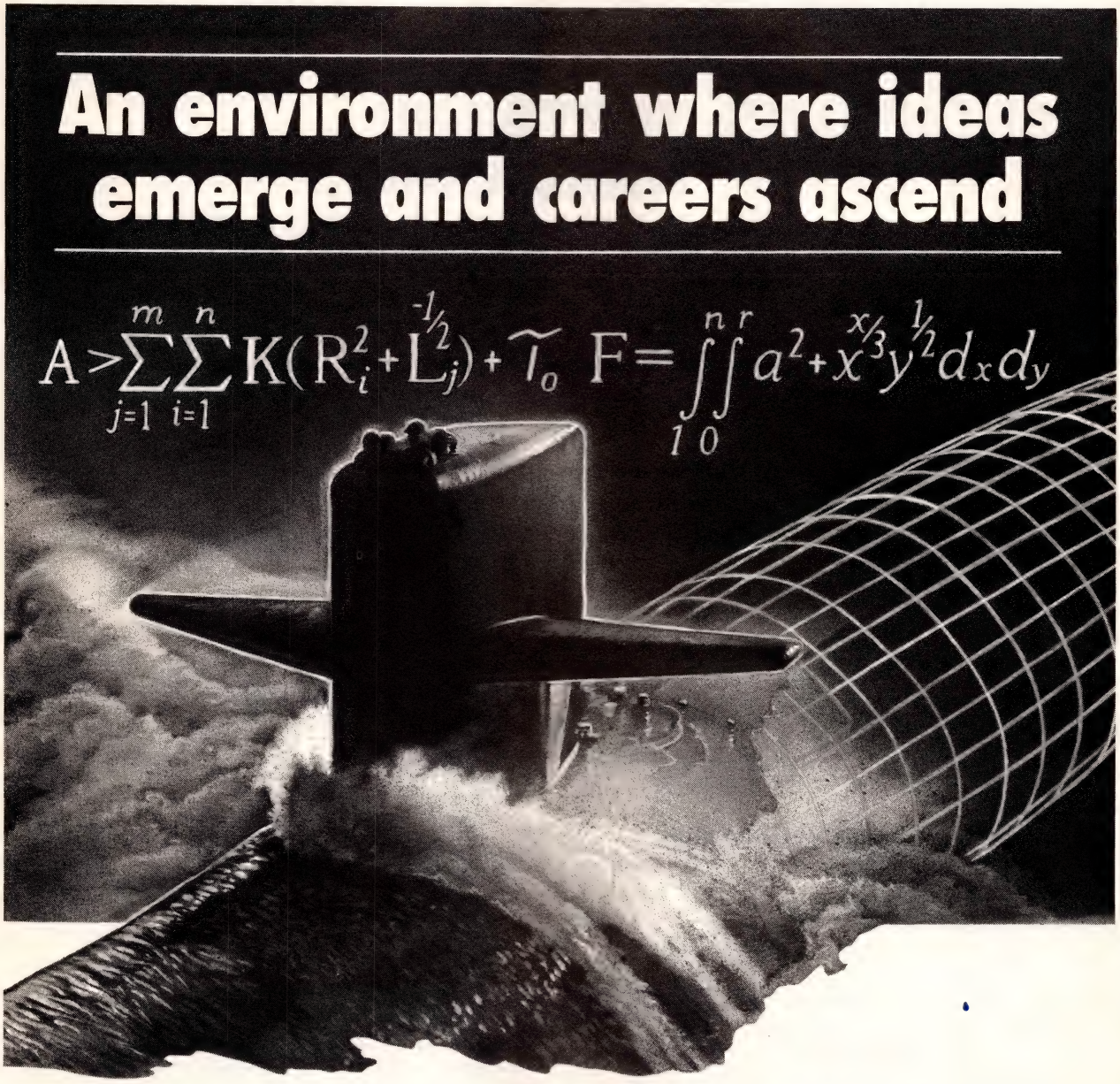

Great things are happening on the banks of the Middle River. Martin Marietta Baltimore Aerospace is expanding its research and development capabilities on a variety of naval systems and investing millions for research, equipment and facilities to advance technologies on military projects. Ideas are emerging and careers are taking off.

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- Advanced Light Weight Sonar
- Remotely Piloted Air Vehicles
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- ASW Research & Technology
- Surface Weapons Systems
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If you are a naval systems, ocean or robotics engineer interested in contributing to emerging technology, consider one of these opportunities at Baltimore Aerospace:

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- Integration
- Test & Evaluation

Software Engineering
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- C3I Applications
- Structured Analysis

Systems Analysis
- Operations Research
- Simulation & Modeling
- Mission Analysis
- Sensor Performance

Robotic Systems
- Telepresence
- Supervisory Vehicles
- Manipulator Design

At Baltimore Aerospace your engineering efforts will not go unnoticed. The more you contribute the faster you'll advance your career. Martin Marietta's employee benefits and compensation package is one of the very best in the industry.

Please send your resume to: Martin Marietta Baltimore Aerospace, Attn: Bill Muth, Dept. EDN331, 103 Chesapeake Park Plaza, Baltimore, MD 21220. An equal opportunity employer. U.S. Citizenship is required. Personal background investigation may be required.

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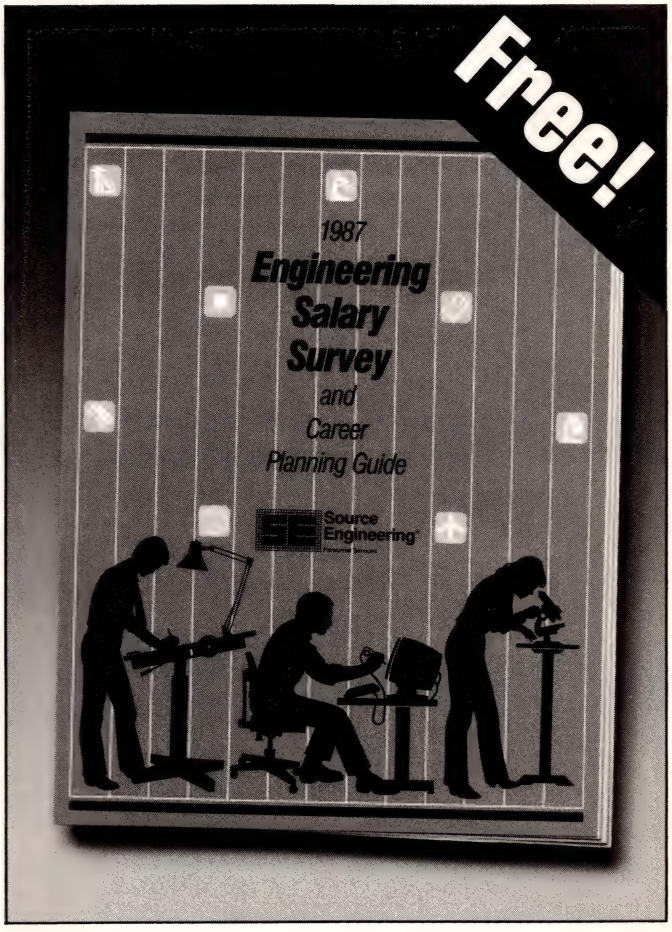

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Production Design Environment

Product development in a production environment is one of Micron's unique and valuable attributes. Our Research and Development Department employs circuit designers, layout engineers, product engineers and technicians who mutually participate in product development.

The work climate at Micron is characterized by hands-on participation at all levels of the organization. Micron's reputation for innovation in circuit design, quality manufacturing and product reliability is due to the contribution and ideas of our people. And we consider our people to be our most valuable asset.

A Diverse Future

Micron's strategy for the future is to diversify its product line and expand its customer base. Our first steps toward product diversification include 2- and 4-MB memory expansion cards for IBM-compatible PCs. Our next steps will further enhance Micron's reputation for product innovation.

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DRAM Design Engineers
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EEPROM Test Engineers

PRODUCT
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EEPROM Product Engineers

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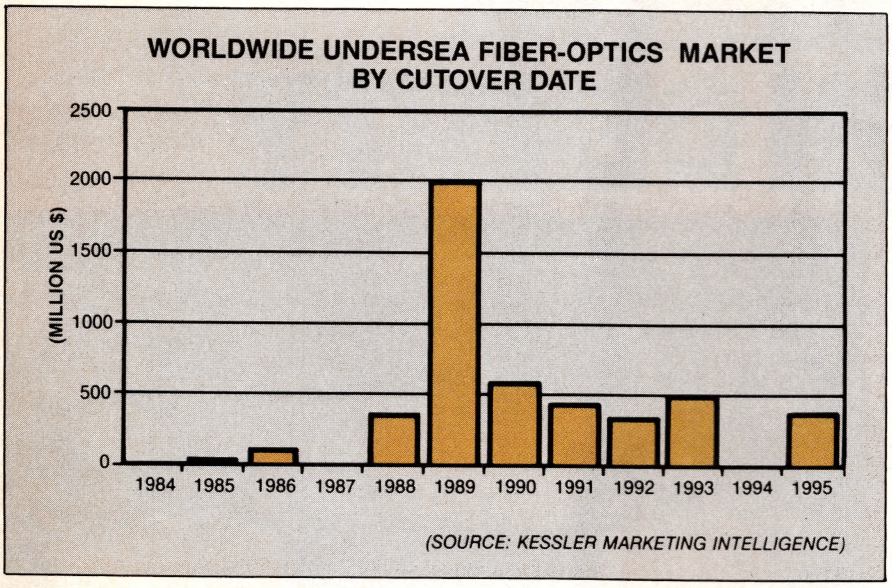

Fiber optics is the choice for undersea communications

Through the next eight years, undersea communications systems will form one of the largest markets for fiber-optics technology, says the market-research company Kessler Marketing Intelligence (Newport, RI). From a base of $117 million in 1986, the worldwide market for fiber optics in undersea links will grow to $2 billion in 1989. Although growth will be sporadic (systems will not be "cutover," or put into operation, at an even rate—see **table**), the cumulative market will be worth approximately $4.79 billion through 1995.

Communications authorities and systems builders are planning to construct five transatlantic and three transpacific fiber-optic cables. Engineers began placing the US shore end of the first transatlantic cable, TAT-8, in November 1986. The dramatic increases in communications capacity will challenge cable operators to develop sophisticated services that will make the systems pay. In addition to the usual voice traffic, operators are planning to offer broadcast quality video and dedicated data channels. "It's not certain that the world needs all this bandwidth all that soon," says KMI analyst Robert Holtzman, "but with the US long-haul market as a model, we can expect that a large percentage of the planned systems will be built."

According to KMI, charges for development costs will account for the largest portion—32%—of the market for fiber-optics technology through 1990, followed by the costs of cables and repeaters. By 1995, however, systems operators will have amortized most of those development costs. Improved laser technology and 1500-nm transmission will allow longer distances between repeaters. The expenditure for these electronic components will therefore constitute a smaller percentage of the total systems cost.

Military and video use will drive ADC, DAC market

Applications in military systems and in video and graphics equipment will make the greatest leaps in demand for A/D and D/A converters compared with other uses, reports the market-research company Venture Development Corp (Natick, MA). Military systems, which already account for a plurality of data-converter applications, will increase their use of the components at a 19% annual rate, to a 1990 value of $361.5 million. Video and graphics systems will show even greater growth, at a 28.4% annual rate, to a 1990 value of $145.8 million.

Avionics and missile systems accounted for the bulk of military applications of A/D and D/A converters in 1986, says VDC. Surface systems and underwater systems, respectively, are the next largest consumers of the devices in the military sector. The Reagan Administration's vigorous defense buildup has been a boon to the data-converter industry, says VDC, through such large defense projects as Milstar (Military Strategic Tactical and Relay satellite systems). Radar applications will spur further expansion in the use of data converters by the military.

The second largest set of applications for D/A and A/D converters is in instrumentation, including laboratory equipment, data-acquisition systems, and automatic test equipment (ATE). This segment accounted for approximately 21.5% of all converter shipments in 1986. Within this applications sector, ATE is expected to show the greatest increase in converter use over the next few years, VDC reports. Growth in this and other areas, however, will be somewhat offset by OEMs that expect to shift from purchased converters to captive production, and those that are turning increasingly to less expensive V/F converters.

Video and graphics applications, which accounted for $53.6 million worth in shipments in 1986, include television broadcast equipment. Although digital television may take five years before it has any impact on the US marketplace, other areas of video and graphics are expected to make rapid increases in converter use over the next five years. Most of these applications will require high-speed A/D and D/A converters.

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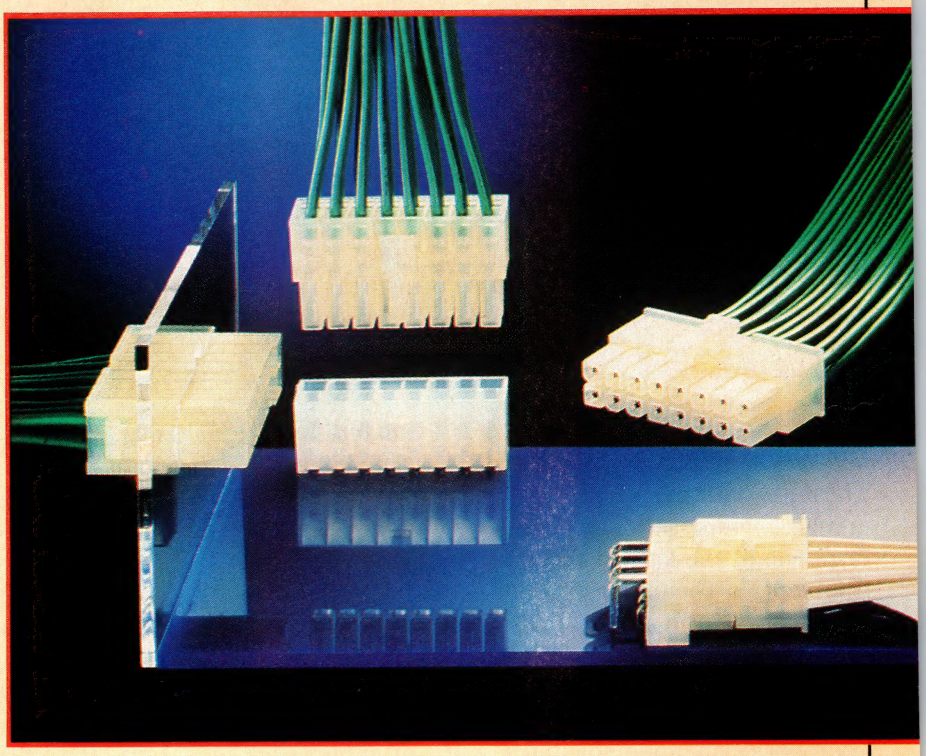

From power supply to power distribution, Molex makes the connection.

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Mini-Fit Jr. meets today's demand for miniaturized design components.

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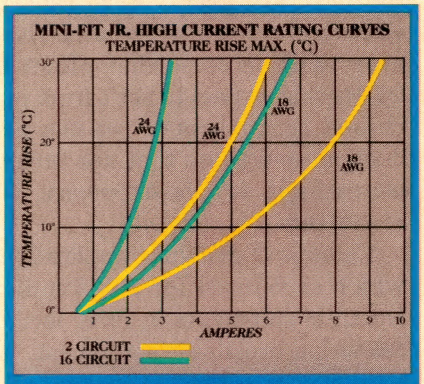

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A special kind of craftsmanship

Universal Data Systems, the company that developed the first 9600 bps dial-up modem, has now applied its special brand of craftsmanship to the CCITT V.32 specification.

The result is a *full-duplex* 9600 bps device for the switched telephone network. When substandard line conditions are encountered, the device offers automatic fallback to 4800 bps, while maintaining the full-duplex communications capability.

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